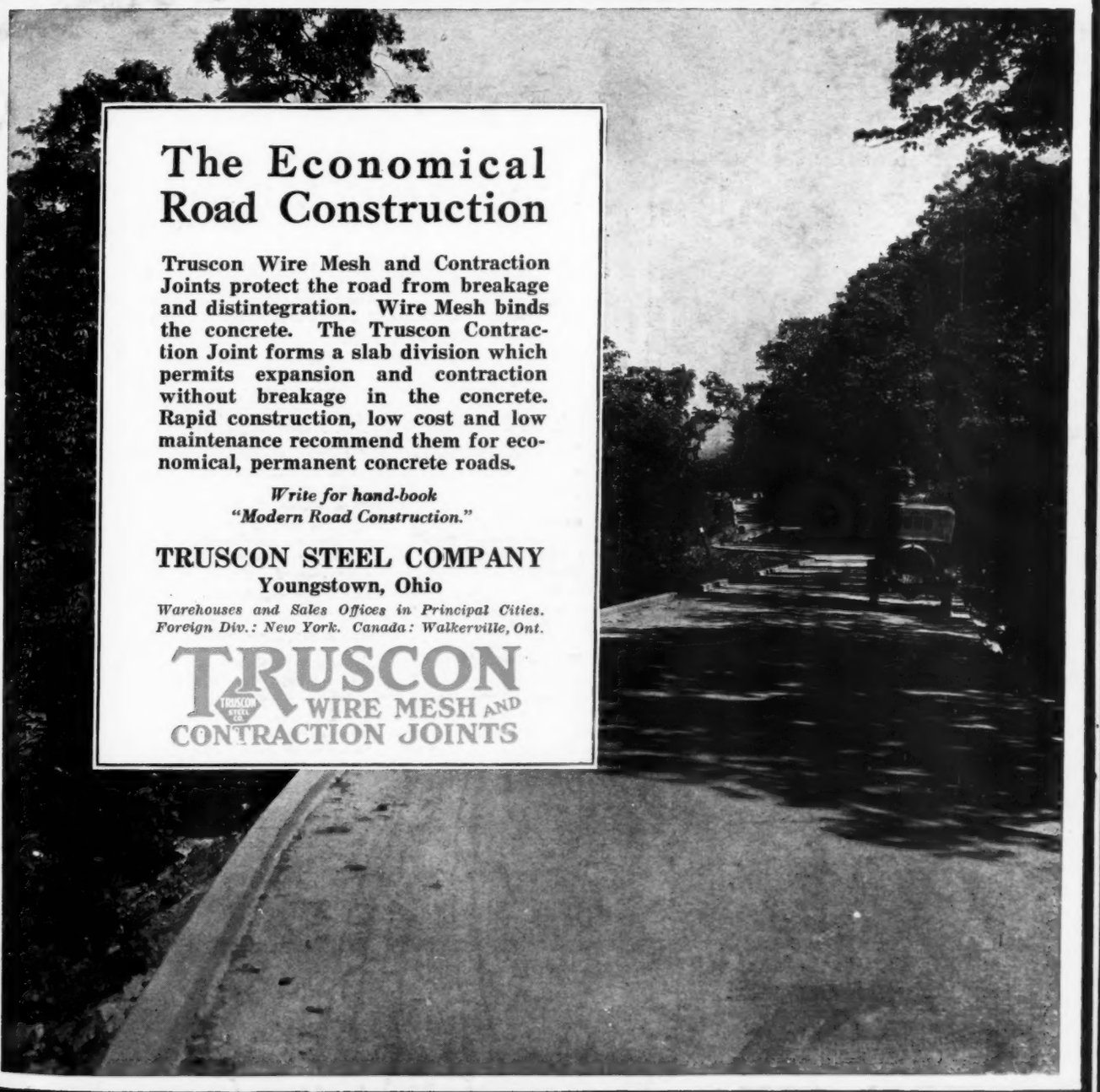
PUBLIC WORKS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Road Construction
Truscon Wire Mesh and Contraction Joints protect the road from breakage and distintegration. Wire Mesh binds the concrete. The Truscon Contraction Joint forms a slab division which permits expansion and contraction without breakage in the concrete. Rapid construction, low cost and low maintenance recommend them for economical, permanent concrete roads.
Write for hand-book
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WIRE MESH AND
CONTRACTION JOINTS

MAY, 1925

The Austin Motor Grader

WITH LEANING FRONT WHEELS

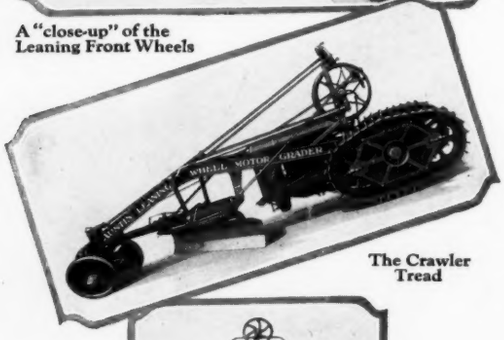
THE patrol system of road maintenance is generally admitted to be the best possible method of keeping earth, gravel and similar roads in good condition at all times. A road that is systematically maintained will always be a joy to those who travel over it, and will never get into such shape that it will need expensive grading.

Motorized patrol graders are becoming increasingly popular in all parts of the country, and of these motor-propelled machines the Austin Motor Grader is without doubt one of the most, if not the most, efficient.

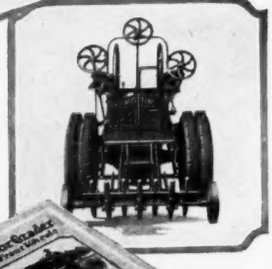
The Natural Grader built in the Natural Way

The operator of the Austin Motor Grader has directly under his hand all Motor and Grader Controls, and stands at the rear of the machine where every practical reason for motor and grader operating demands that he should stand. [Contrast this with other types of Motor Graders on which the operator is stationed in front of the tractor, which is not only a hot place, and a dangerous one, but also an unnatural place because the Motor Controls have to be extended out to the front where they do not belong, and the operator stands directly above the blade where no practical grader operator would ever choose to stand, and where, in the forty years road graders have been made, no operator was ever before asked to stand.]

A "close-up" of the Leaning Front Wheels



The Crawler Tread



The Rear Scarifier is sturdy and strong

Our Special Motor Grader Bulletin discusses the subjects of road maintenance in general, and motor grading in particular, in detail. The coupon makes it easy to ask for your copy.

EQUIPMENT

The exclusive leaning front wheels, illustrated at the left, are probably the most popular feature of the Austin Motor Grader, and are alone enough to account for its remarkable efficiency. The front ends of ordinary road graders are kept from slipping sideways by the teams or tractors used to pull them. The front end of a motor grader is not hitched to anything, and, therefore, has a tendency to slip sideways, which tendency can best be overcome by the use of leaning front wheels.

These leaning wheels in combination with the crawler tread, also illustrated at the left, enable the Austin Motor Grader to work on shoulders and in ditches where a straight-wheel motor grader with ordinary rear wheels would be useless. The crawler tread is also to be preferred for use in soft or sandy soils.

Two types of scarifier attachments are provided; the center type, which is fastened to the blade circle, and the rear type, illustrated at the left, which is intended for more difficult work.

Please send me Bulletin a Motor Grader

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THE AUSTIN-WESTERN ROAD MACHINERY CO.

CHICAGO

VOL. 56 NO. 5

Entered as second-class matter at the Post Office, at New York, N. Y., Sept. 1, 1922, under the Act of March 3, 1879.
Published monthly by **PUBLIC WORKS JOURNAL CORPORATION**, 243 West 39th Street, New York, N. Y.
Subscription price $3.00 a year, single copies 35 cents.
MAY, 1925

PUBLIC WORKS

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 56 MAY, 1925 No. 5

California State Highway Equipment Department

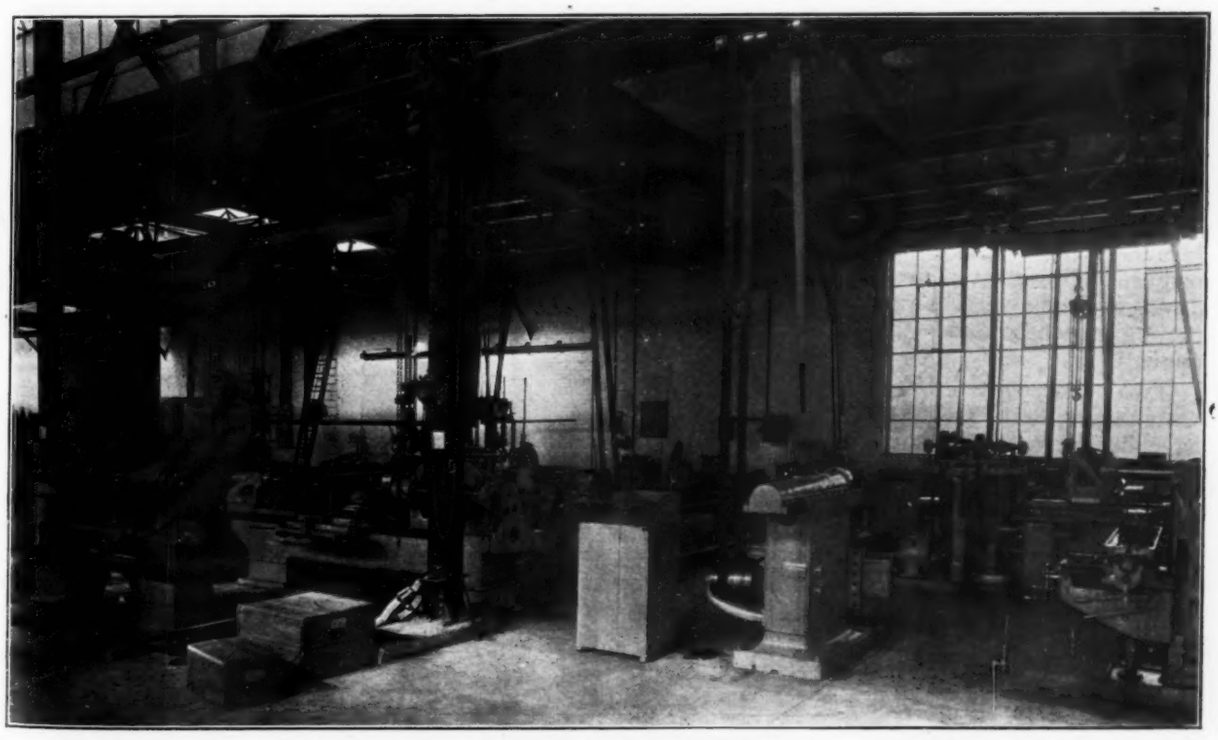
Numerous repair shops and maintenance yards operated by the California State Highway Commission for repairing and maintaining motor equipment used in building and maintaining the highways throughout the State

In order to house and care for the trucks and equipment allotted the several divisions of the California State Highway Commission and to facilitate the issuance of tools and materials as needed, division shops and warehouses have been established at Willits, Redding, Fruitvale, Petaluma, San Jose, San Luis Obispo, Fresno, Bishop and Lankershim, and a central shop and warehouses at Sacramento.

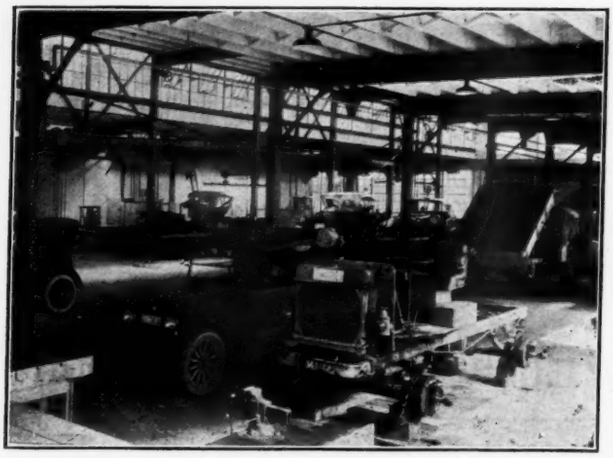
The several division shops have been equipped with machinery and tools necessary for making routine repairs, and the central shop (also called headquarters shop) at Sacramento is fully equipped for the overhauling of all the equipment of the Highway Commission. Nearly all the machinery and tools needed to equip these shops were received from the Federal Government.

Prior to the distribution of surplus war material by the government, comparatively little equipment was owned by the Highway Commission. As soon as it became apparent that a considerable quantity of equipment would be received from the government, an equipment department was organized at headquarters and given general charge of all equipment, as well as the distribution of supplies from government stock; also direct charge of the central repair shops at Sacramento and general supervision over the use and repair of the equipment of the several divisions.

The central repair shops and maintenance yard at Sacramento cover approximately four acres and represent an investment of something over $250,000. This includes the cost of the labora-



VIEW IN MACHINE SHOP.



VIEW IN REPAIR SHOP.

tory building, which totaled $30,000, and the storage yard of Divisions III and X, but equipment for the shop in the way of machine tools, lathes and drills received from the Federal Government is not included in this $250,000. Surplus war equipment in the way of power tools now in use is valued at approximately $30,000. From January 1, 1923, to May, 1924, expenditures for road-building equipment aggregated about $300,000, and those for motor vehicles over $180,000. Nearly all the money expended for motor vehicles has been for the rehabilitating and equipping of trucks received from the United States Government, and the purchase of passenger vehicles to replace those worn out in service.

The central shop is a one-story brick building, well lighted and covering a floor area of about 26,000 square feet. It is completely equipped for the repair of all classes of equipment, and is one of the most complete shops of this nature in the State. The machine shop equipment includes three lathes, a planer, crankshaft grinder, cylinder grinder, universal and cutter grinder, five-foot radial drill, universal milling machine, hand milling machine, 28-inch sliding head drill, sensitive drill, tool grinders and other minor tools. The equipment of the blacksmith shop includes spring and felloe-band furnaces, heat-treating furnaces, two down-draft forges, a hydraulic tire press, oxy-acetylene welding and cutting torches and other minor tools.

Two corrugated iron warehouses, each 60x140 ft., have been erected to house trucks and materials awaiting distribution, and a galvanized iron building formerly occupied as a shop by the Highway Commission is now utilized as a warehouse for small tools and supplies.

Among the accomplishments of the central shop possibly the most interesting is the utilization of war material for purposes other than that for which it was designed. A striking example of this is the use that has been made of Cadillac engines secured from the government. Just before the close of the war the ordnance department designed a 2½-ton catipillar tractor capable of operation at high speed and driven by an eight-cylinder Cadillac engine. Only about 70 of these tractors were assembled previous to the armistice, but a large number of the eight-cylinder Cadillac engines had been delivered for use with these tractors. R. H. Stalnaker, equipment engineer in charge of the Central Repair Shops, secured a number of these engines for California and designed and built power plants in which they were utilized for driving rock crushers, effecting a saving on each of about $1,500 as compared with the cost of a commercial plant capable of performing the same work.

One make of truck distributed to the State by the government was fitted with a pressure gasoline feed system which was a source of much annoyance and expense. The State succeeded in securing from the government some 200 vacuum tanks, intended for use on tractors, and are installing these tanks on the above trucks whenever they come in for repairs. A considerable saving in the cost of repairs has been made possible by this change and so far the vacuum tanks have given no trouble whatever.

Another interesting development of the central repair shops is the department established to do repair work on automobiles belonging to other state departments located in Sacramento and vicinity. This department is fully equipped to do efficient repair work in the shortest possible time and at minimum cost. One of the officials of the agricultural department wrote to the head of the equipment department of the highway commission: "The Chief of my Division wishes me to take this opportunity to express to you our appreciation and satisfaction with the work done at the Central Repair Shops on the cars operated by us. We believe that the present arrangement of having repair work done by your Commission has worked out not only more economically but more efficiently than the old system."

EXTERIOR VIEW SHOWING. FROM LEFT TO RIGHT, THE OFFICE, STOCK

Twenty-one three-yard trucks recently have been turned out at the central shop, fifteen of them being reinforced with the planking. All are equipped with underbody hydraulic hoists with a dumping angle of 48 degrees. This type of truck is doing a great deal to speed up handling of material.

The Central Repair Shops recently completed the delivery to the various divisions of the Highway Commission of ten new sprinkler pump outfits equipped with 1,000-gallon tanks, mounted on Liberty trucks, which are used for sprinkling dirt roads and watering trees. A labor-saving feature of the new sprinklers is a loading unit consisting of a 2½-inch centrifugal pump with a power take-off from the transmission. It is placed so as to insure efficient handling and filled the tanks in five minutes on test.

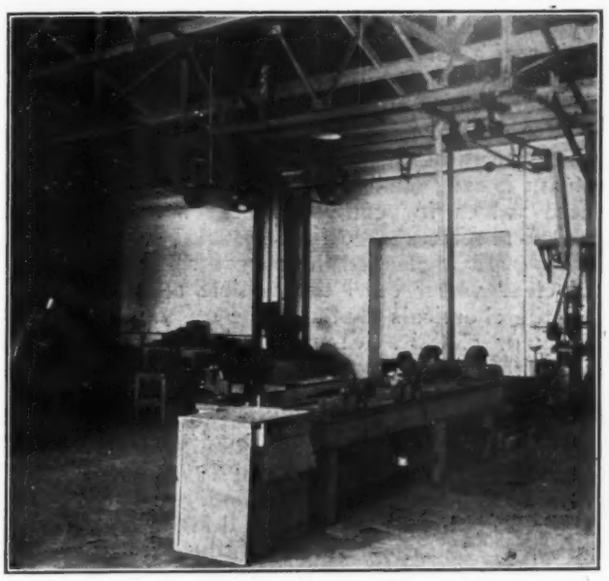
Some of the things successfully done in the way of repairing or working in government material are as follows:

About all the cast bronze used in the shop is recast from bushings and castings received from the government together with the necessary proportion of copper added. This recast bronze costs 15 cents per pound when the Commission formerly paid approximately 36 cents for purchased bronze.

About all the brake lining used on the trucks is that which has been cut down in the shops from over width government stock by using circular shears. The approximate cost of cutting down the lining is 2 cents per foot.

Another successful operation in repairing which saves considerable expense is the filling of wrist pin scores in cylinders. The success of this was practically demonstrated recently. A Packard block that had been filled several months ago was accidentally run low on oil enough to score the cylinders and pistons, but the score fill stayed in. The score fill metal is put in by a small torch which burns city gas and oxygen. The metal is made of lead, tin and a small percentage of copper.

In boring bearings with a boring bar there is a saving of from 25 per cent to 50 per cent in time and scraping. The connecting rod bearing boring machine also saves about the same percentage in time over hand scraping.



VIEW IN BLACKSMITH SHOP.

The oiled duck received from the Government has been used in covering tops, cushions, making curtains, tents and flies.

Approximately 125 old type Nash Quad tool boxes received from the Government were cut in half, ends welded in and made over into a more suitable size truck tool box at a cost of $2.99 each.

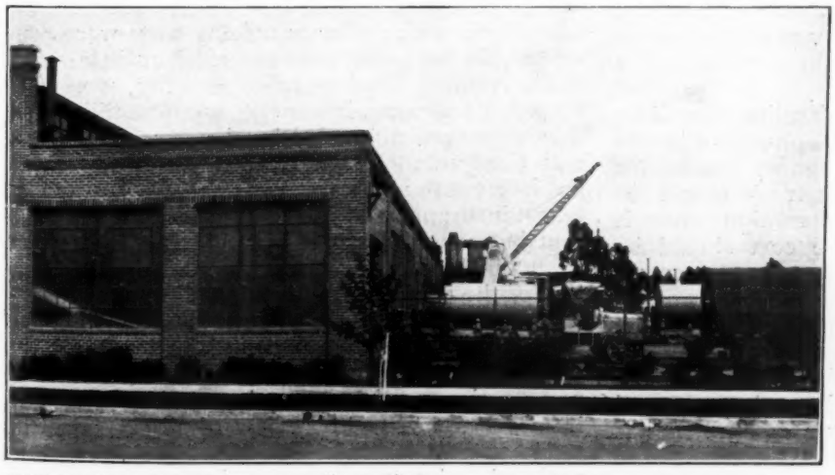
A quantity of link chain has been utilized in making skid chains, mostly of the Commission's own design.

All reground and overhauled motors are run in from 12 to 18 hours before being installed in the trucks. This has reduced the trouble of scored cylinders to a minimum.

A quantity of white lantern globes received from the Government were colored red to make them suitable for protection purposes. A saving of approximately 50 cents per lantern was accomplished.

The shops are using phosphorous bronze tubing for spring bushings. This has netted a saving of about 50 per cent on costs of bushings and it seems to be working out very satisfactorily.

A few weeks ago steam and chemical cleaning of trucks was adopted, which has proven very successful, having cut down the time in cleaning 50 per cent. The chemicals used in cleaning are soda ash and caustic soda properly mixed with water, all being placed in an oil drum mounted on the road roller. The chemicals are mixed and heated in the tank



ROOM, REPAIR SHOP, AND STORAGE YARD FOR MOTOR EQUIPMENT.

by means of steam pipes connected with the boiler of a road roller that is used very little for rolling work. The operator first adjusts the flow of chemicals at the jet and then the steam under 40 lbs. pressure is turned on at the boiler, when the operation of steam cleaning begins. The steam nozzle, made at the shops, has hand-operated valves for controlling the steam and the chemical mixtures. After a truck has been thoroughly steam cleaned the operator turns a stream of clear water onto the vehicle and cleans off all the chemicals that may be on the surface of body or chassis. Compressed air is then used for blowing water off the motor and transmission.

By this new method a three-ton truck can be thoroughly cleaned in three hours by one operator. The same work formerly required from 6 to 10 hours by the old method. Fuel for firing the road roller consists of oil drained from crank cases of the autos and trucks being serviced or overhauled at the shops.

Management of Equipment Department

By R. H. Stalnaker*

One of the striking developments in highway building during recent years has been the remarkable increase in the use of machinery and specialized tools. With this change in methods of construction and maintenance, the problem of properly equipping a department or an outfit to do necessary work in connection with highway building to the best advantage and at the least cost has become increasingly complex.

It is the function of the Equipment Department of the California Highway Commission to handle all questions relating to the purchase, use and care of equipment employed in road construction operations throughout the state, including the repair and distribution of surplus government war material.

In connection with these duties one of the vexing problems which has confronted the department in the past was that of a just distribution of the cost of upkeep of equipment against the work on which it had been used. For example, a truck might be in operation a year or more on numerous jobs, and possibly in two or three divisions before reaching a point where it required a thorough overhauling.

Theoretically the cost of overhauling should be prorated against the several jobs on which it was employed, but the task was almost impossible as each man who had used the truck would insist that it was in first-class condition when it was in his hands and that the cost should be charged to the others.

In order to minimize these difficulties and to provide for proper depreciation charges, as well as to comply with the law passed by the legislature, requiring that a charge for depreciation of equipment be levied against all work performed by day labor, all state highway equipment has been placed on a rental basis.

*Equipment Engineer of California Highway Commission.

Rentals are so fixed as to cover, on an average, the cost of repairs and upkeep and an allowance for depreciation based upon the estimated life of the equipment. This system was put into effect January 1st, 1924, and so far has succeeded beyond expectations.

Under this system the road-building equipment of the Commission has been divided into two classes, rental and non-rental. The rental equipment includes all road building equipment of a fairly permanent nature and reasonably high value, while the non-rental equipment includes small tools and articles of comparatively short life, such as tents and articles of camp equipment, stoves, etc. These articles are used only on large jobs, and, together with the repairs on them and the cost of small tools, are charged direct to the job. The job is credited with the salvage value of any equipment transferred to other work, or left on hand at the conclusion of the work. The cost of small tools bought for use on general maintenance is applied to a suspense account, the total of which is prorated annually against the expenditures for general maintenance in the division concerned.

The rental equipment is divided into two classes: automotive, including passenger cars, motor trucks and motorcycles; and construction, including tractors, graders, crushers and all other major equipment used in road construction and maintenance. The distinction between rental and non-rental equipment (apart from small tools) is largely arbitrary, but is in general based on the probable permanence of location of the article in question during its useful life, and the likelihood of its future usefulness on other jobs.

The fixing of proper rates for rental involved much study. Few data were available except the suggested schedule of equipment rental prepared by the Associated General Contractors of America. Excepting on motor vehicles, no records of cost of upkeep had been kept by the Commission. These were of little value, as nearly all the automotive equipment had been received from the federal government, and large quantities of spare parts for the various vehicles were distributed with them. These parts, distributed free of charge to the state, had not been charged for when used, and, so far as upkeep costs were concerned, the cost data were therefore of little value.

The rentals fixed were necessarily somewhat tentative and were, in general, considerably lower than those recommended by the Associated General Contractors, even after allowance is made for items not applicable to state work, such as taxes, insurance and interest on investment. Except in unusual cases, it was felt that the service on maintenance work, on which the major portion of the equipment is employed, was much less severe than that on the average contract job, and that the cost of upkeep would be less, and the useful life of the equipment longer on that account. Some adjustments in rates have already been necessary, and a review of all rates will be made as soon as sufficient data have been accumulated. Average returns, however, are very close to those anticipated.

All rental equipment has been assigned numbers for the purpose of identification, and an accurate account of cost of upkeep and rental received is kept for each article. The accounts of the departments are all segregated so as to afford full information as to relative costs in the various divisions.

During the first six months of 1924 the total amount of rental assessed was approximately $765,000 and the approximate cost of administration, upkeep and expenses in connection with the transfer of equipment between divisions was $408,000, leaving a balance of $357,000 available to cover depreciation and purchase of replacements.

North Carolina's Road Program

Charles M. Upham, chief engineer of the North Carolina State Highway Commission, in a paper before the North Carolina Section of the American Society of Civil Engineers, discussed the future road program adopted for that State, and in connection therewith brought out certain ideas and opinions that are of general application and interest. Some of these are given in abstract in the following paragraphs.

Every state is justified, when beginning its road construction, in issuing bonds so as to spread out over a series of years the payment and retirement of the bonds by those benefited by the investment. To carry on a large initial program under the so-called "pay-as-you-go" plan would create an excessive tax and delay the construction of the system to such an extent that the progress of the states as a whole would be retarded. After a start has been made by means of bonds, however, the state should slowly and gradually change the method to the pay-as-you-go plan. This automatically adjusts itself, for after the bond money has been spent in constructing the highways, the large number of new users will increase the revenue to an extent that will not only pay the interest and sinking fund on the bonds, but will allow a certain amount for payment of new construction. Thus the state will gradually, as its highway system develops, pass from the bonding to the direct revenue method of financing. North Carolina can, no doubt, construct a highway system and in a few years pay for the entire system from the revenues derived from the savings of the highway users. "This is the only case I know of where you can eat your cake and have it too."

North Carolina has already spent or contracted $65,000,000 and an additional bond issue of $20,000,000 is practically available. This will not necessarily all be spent on hard-surfaced roads. A recent report of the Highway Research Board stated that the immediate need is to meet the traffic requirements and build a road that will be passable every day in the year, rather than construct a shorter mileage or high-type pavement. If the pavement is of too low a type, the maintenance charges will be high, but on the other hand if it is of too high a type, the traffic may not justify the expenditure.

The selection of the type of pavement is probably the most difficult problem in highway construction. It depends upon many factors, which, as a rule, are handled differently in practically every state. The immediate traffic demands together with the anticipated traffic within a reasonable number of years; the character of the locality through which the road is to be built; whether the road is to be used for commercial purposes or as a tourist road; whether it will be subjected to very heavy truck traffic or to light truck and passenger traffic; the availability of local materials for construction; whether the road will be affected by weather conditions; the topography of the country through which it passes; the location of villages and cities; grades; alignment, and many other details—all these are factors which are to be considered when selecting the type of pavement.

In North Carolina, in districts where it is known that the road will be subjected to a large number of vehicles and a high percentage of heavy trucks, the Highway Commission has constructed hard-surfaced pavements which have adequately taken care of this kind of traffic. In other localities where the present traffic demands and surrounding conditions do not warrant the construction of the higher cost road, the progressive type of road is built. In constructing the latter, the lines, grades and drainage structures are built in accordance with standard practice for hard surface, for it is considered that some day the road will be hard surfaced; while the surface is constructed of a selected material, either topsoil, sand-clay or gravel, which makes it possible for the road to be used throughout the year and carry a medium amount of traffic. Such a road is generally maintained with a road drag or road machine and is in reality the future subgrade for some type of hard surface. When the traffic on such a road becomes so greeat that the maintenance cost is excessive, a better type of road is then desirable. The cost of the progressive or subgrade highway varies from $4,000 to $9,000 per mile, while the cost of a hard surface will vary from $30,000 to $40,000 per mile.

Until recent years there was no type of road intermediate between the selected-soil roads and the hard-surfaced roads. But recently the North Carolina Highway Commission has developed a surface that seems to be satisfactory for secondary roads but costs much less than the hard-surface roads. These intermediate roads are of three types, one of which can be constructed at a cost of $2,000 to $2,500 a mile, another costs $12,000 or $13,000 a mile, and the third costs from $18,000 to $21,000.

By following out this plan of progressive construction the cost of road construction will continue to be an investment.

Repairing a Broken Sewer

Sewage diverted temporarily to creek and sewer replaced or reinforced with concrete or with a steel lining. Final collapse due to heavy trucks.

The method employed for meeting some unusual difficulties in repairing a broken sewer was described in a paper before the New Jersey Sewage Works Association by Paul Molitor, superintendent of the Madison-Chatham (N. J.) Joint Sewage Treatment Works. This sewer was built in 1894 and has been in continuous operation since then carrying the entire sewage flow of the towns of Montclair and Glen Ridge, and approximately two-thirds of that of Bloomfield, a total population of 50,000. On its way to the Passaic Valley sewer it passes through the center of Bloomfield on Washington Street, being at this point from 20 to 22 feet deep and 24 inches in diameter.

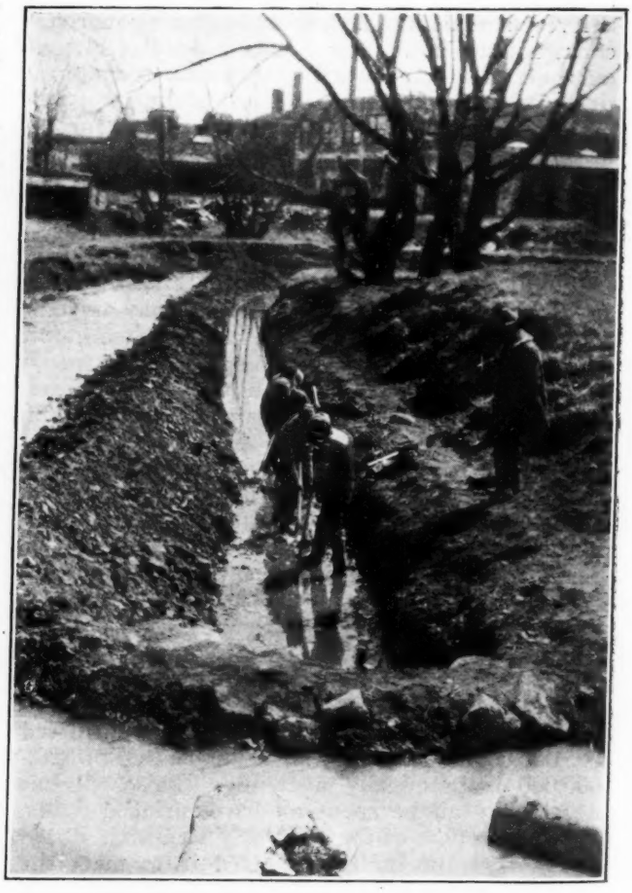
For some years this sewer for a considerable distance above this point had been flowing under pressure and after heavy rains (probably because of leaking joints or breaks) had backed up into houses and even overflowed into the street. In March, 1924, basements of dwellings and business houses in Bloomfield were flooded and considerable damage caused, and Mr. Molitor assisted the city engineer of Montclair in investigating how best to remedy the defect.

It was first necessary to divert all or most of the sewage flowing past this point. Owing to the quantity it was decided that pumping would not be practical, and a manhole was built over the sewer a little distance above the point where a break was suspected and a 15-inch pipe run from here into Tony's brook, a short distance away. The sewer here was at a lower elevation than the bed of the brook, and to overcome this difficulty the bed of the brook was divided into two parts by a longitudinal dike, the stream being carried on the further side of the dike, and the half of the bed left dry was then excavated to a sufficient depth to receive the sewage diverted from the sewer. The fall of the brook below this point was such that by carrying the ditch a distance of 200 feet downstream the diverted sewage would flow by gravity into the natural creek bed. When this had been done, the pipe on the lower side of the manhole was plugged and all of the sewage diverted into the lowered section of the creek channel.

This left still a considerable amount of sewage reaching this sewer from Glen Ridge and Bloomfield, but a large part of this was diverted by leading this sewage into another sewer which skirted the affected area and discharged into the trunk sewer below the point needing immediate repair.

When this had been done the trunk sewer was uncovered for a distance of 40 feet at the supposed point of the break. Approximately 30 feet of this section of the sewer was found to be badly broken and full of stones and dirt, causing a complete stoppage. This section of the sewer was rebuilt and a new manhole constructed at the upper end of the break, and from this a sewer-cleaning machine of the bucket type was used for cleaning a section 388 feet from here to the next manhole. About 15 cubic yards of stone and dirt were removed from this stretch. When this had been done Mr. Molitor crawled through the sewer for a distance of 212 feet. The first 104 feet was in good condition, but the next 108 feet, while perfectly round and functioning properly, was cracked at the top and bottom. The next 176 feet was cracked at the quadrant points and had settled so that, instead of being 2 feet in diameter, it was about 1 foot high, while in some places the top had fallen in and allowed stones and soil to enter.

It seemed necessary to reconstruct about 218 feet of sewer known to be broken, and a contract was let for this and for uncovering 108 feet of cracked pipe and reinforcing this with concrete. This was let by contract because, the sewer being well over 20 feet deep, the work would require the use of machinery and equipment that the town did not possess. This work was carried out with diligence and dispatch and



LOWERING PART OF BED OF BROOK

with a minimum of inconvenience to the public.

In addition to this reconstruction and repair, the town employed a novel method of temporarily reinforcing about 40 feet under a street carrying very heavy traffic. This stretch of sewer was cracked and was reinforced by inserting in it cylinders of 3/16-inch sheet steel in 2-foot lengths and of such width as to leave about 6 inches of the invert exposed when placed in position. The edges of these sheets were drawn together so as to make the cylinder somewhat smaller than the interior of the pipe and hold together by chains. After they had been inserted in the sewer as a continuous lining, the chains were released and the steel sheets sprang out against the interior of the sewer. It is believed that this will serve as a temporary reinforcement to prevent the sewer from collapsing and will probably function until the steel rusts out.

Mr. Molitor formed the opinion that the disintegration of the sewer had been going on for some time, since depressions in the street over the sewer had been noticeable for some years and had been filled up from time to time, and the pieces of broken pipe which were removed from the collapsed sewer were rounded on the edges by erosion. He concluded that the failure was primarily due to lack of support under the sewer when it was constructed; to the fact that it operated under pressure, causing sewage to be forced out through the cracks into the soil and, when the flow diminished, the water in the ground flowed back into the sewer, carrying with it soil materials surrounding the pipe; which washing left voids around and above the pipe, following which the ground, loosened by the passing of heavy trucks on the street above in recent years, had fallen on to the sewer and cause the collapse which finally stopped it entirely.

Certified Roadside Water

Pennsylvania's practice of examining wells, springs, etc. along the main travelled highways and posting at each either a warning or a notice of satisfactory quality was referred to in the November issue of Public Works. Much the same practice was begun in Ohio before Pennsylvania adopted it. Nearly a thousand wells along the main Ohio highways have been examined by engineers of the State Department of Health during the past twelve months.

This work was begun in February 1924, when W. H. Dittoe, chief sanitary engineer of the department, assigned Ralph C. Sweeney and C. S. Slade, assistant engineers, to it; Dr. W. Johnson being added later. They examine two classes of water supply—those supplying hotels, restaurants, schools, factories, and country clubs; and wells at small schools, tourist camps, summer resorts, churches, fair grounds, gasoline filling stations and along roadsides.

The supplies are examined as to possible sources of contamination; as to type and construction of well etc.; and by analysis of samples. If found satisfactory, this is certified by a "Seal of Safety." This is a small, yellow enameled metal disk which is placed on the pump barrel where it will be easily visible. The disks are serially numbered and dated. Where the supply is delivered under pressure in buildings, a framed "Certificate of Safety" is placed in a conspicuous place in the building. The Division of Highways also supplies standard road signs marked "Safe Drinking Water 500 Feet Ahead," which are placed along state maintained roads.

Most of the work has been done by engineers from the central department at Columbus, but periodic re-examination are made by county health officials, and during this year co-operation with county health departments will be greatly broadened. A gratifying feature of the campaign is that owners of private wells are asking for examinations of them by the health authorities.

A large percentage of the supplies investigated have been found unsatisfactory, usually because of their location with reference to privy vaults of the leaching type or other contaminating agencies. Many owners are glad to correct these defects when told how to do so.

Meter Shop Methods*

By A. P. Lovell†

The best account of practice in San Diego may be given by following the meter from the time we receive it from the manufacturer.

All meters as delivered to us are put on the test bench, tested and sealed. The meter shop foreman delivers the meters to a service foreman on request, checking each meter by make, size and number. When installed by the service crews this same information is given on service installation order and returned to shop clerk, who makes out a card for each meter and files it.

In due time, from wear, sand or some of the various causes with which we are all more or less familiar, the meter reader will find this meter dead or in his estimation not registering correctly. The meter reader carries a pad of blank forms on which he notes his findings and attaches this to the page of his meter book carrying the record of this meter. These books all go through the hands of the chief meter reader who removes trouble slips and transfers notes to what we term a meter change sheet.

This sheet shows the name and address of the property owner, tap number, number of meter reader's field book, style, make and number of meter, together with last reading and date taken. This sheet is forwarded to the field repair crew who change the meter and return it to the meter shop with a card attached showing why the meter was removed and also all data on meter installed in its place. On the reverse side of this

* Paper before the California Section of the American Water Works Association.

† General Foreman, San Diego Water Department, San Diego, Calif.

card is space for the meter shop foreman to report what repairs were necessary.

In the meter shop the meter is turned over to a laborer who cleans and prepares it for the repairman. It then goes to the repair bench where new gears, disks, or whatever may be necessary are renewed or repaired. When a repaired meter is returned from the test bench, it is tested and sealed and is again ready for service. All dials are set back to zero. Large meters, that is from 3-inch and up, are usually repaired in the field.

When disassembled we often find the meter has been damaged by hot water warping the disk. As we cannot force the property owner to install a check valve on account of the danger of an explosion, we repair the meter and charge property owner for all damage.

The City of San Diego has approximately 26,000 meters in service and these are all cared for by two field and two shopmen.

New services, 3-inch and larger, are now cared for by batteries of 2-inch meters and we are replacing existing large meters with batteries as rapidly as our funds will permit.

A check of the increase in revenue to the city derived from the battery installation over the large meter is interesting. I shall cite a few instances in which I have taken the revenue from certain services for a month of one year and for the same month of the succeeding year, the large meter being replaced with a battery in the meantime. Of course, we have no means of knowing whether consumption was approximately the same in both cases, but we take for granted it was nearly so.

3-inch meter, store and rooming house	Sept., 1920	$4.45
Battery	Sept., 1921	11.85
3-inch meter, store and rooming house	Nov., 1920	3.00 min.
Battery	Nov., 1921	6.30
4-inch meter, hotel	Oct., 1921	34.05
Battery	Oct., 1922	53.10
3-inch meter, hotel	June, 1923	15.90
Battery	June, 1924	32.40
4-inch meter old disk type	June, 1924	18.30
Battery	Sept., 1924	190.20

Vibrolithic at Yankton

Experience with this pavement at Yankton, South Dakota, during the years 1923 and 1924.

By C. H. Conrick, City Engineer

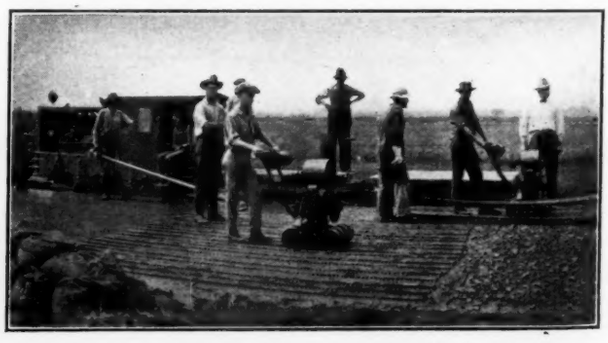
Vibrolithic concrete pavement may be defined as a method of construction applied to the usual practices in concrete paving with possible slight variations in aggregate proportions; also a wearing surface of special stone embedded in the top of the concrete slab.

This method of construction is to vibrate the concrete mixture directly after the depositing and spreading of the concrete on the prepared subgrade. This is done by means of vibrating machines, which are small hand-pushed gas engines mounted on a fourwheel truck, the flywheel of the engine being purposely thrown out of balance, which, together with the explosions, cause the machine to transmit a shaking motion to the concrete. These machines are pushed back and forth over especially constructed grids or platform boards 12 feet long by 16 inches wide, placed on top of the struckoff concrete so as to cover the entire surface from curb to curb.

This operation is repeated several times, until completed. The machines may be stopped on high or rocky spots at will. The observed effects are: The excess water which the concrete contains rises to the surface and runs down the gutters in a small stream; next, air bubbles will be seen escaping from the concrete; finally, a coat of mortar about ¼-inch thick comes to the surface. The result of this vibration process is to densify the concrete by removing the excess water and freeing the entrapped air, each particle of the aggregate settling into the most compact position and making a good contact with the subgrade. The grids having been moved forward, the finishers can walk on top of the slab with impunity, only the imprint of the shoe soles being seen. The concrete is then floated and belted, and after the usual three-weeks curing period, is opened for traffic.

It may be that a three-weeks period is unnecessarily long. By way of illustration, on a

WALKING ON FRESHLY COMPACTED SLAB. IN BACKGROUND BATCH CARS BRINGING CONCRETE MATERIAL.



VIBRATORS COMPACTING CONCRETE. PLACING VIBRATION PLATFORMS.

recent paving job in Yankton an automobile was driven on the green concrete by accident just after the initial set had taken place. This left scarcely a mark, and to date no damage is evident. Variations or slight changes in mixing may be found desirable during construction, as it seems that more coarse aggregate can be properly used with a given amount of mortar than in standard non-vibrated concrete. This we believe is a good feature; the more stone the better, provided there is sufficient mortar to properly fill all the voids.

An especially selected and graded crushed stone is spread evenly over the struckoff concrete just in advance of the placing of the vibration platforms. This layer of stone is embedded into the concrete by the vibrating. It is noticeable that the stones turn flat side up under the vibration, and lie level just under the top coating of mortar; hence, as the mortar coat wears off the stone is ready to offer the maximum resistance to traffic abrasion.

The cost of vibrated concrete pavement is slightly more than ordinary concrete pavement constructed under similar specifications. The principal added cost is the additional machinery, labor and top stone and the expert supervision—a service charge which is not excessive, as compared with the total cost of the pavement. Out here the cost is from 7 per cent to 20 per cent higher.

Yankton City has about 200 traveled blocks of city streets, of which 143 or 72 per cent are now paved with concrete. The first paving, done in 1915 and 1916, consisted of 74 blocks of standard, non-vibrated concrete, being a 6-inch slab, mix 1:2:3, crushed stone aggregate. This pavement is standing up well, although somewhat rough with high joints and longitudinal cracks quite noticeable on some streets.

The 1923-24 program consisted of 69 blocks of vibrolithic concrete, being a 5-inch slab, 1:2:4 mix, non-reinforced, with crushed stone for aggregate. The pavements laid two years ago and subjected to severe seasonal temperature changes show no sign of deterioration. Only a few small cracks, perhaps one or two to the block, so far have developed. It is smoother than the old pavement, probably due to the leveling action of the longitudinal vibrating boards. In fact, during construction we found

VIEW OF YANKTON VIBROLITHIC STREET

that the straight edge almost was unnecessary, the platform having already left a level surface.

Expansion joints of elastite were constructed at the ends and middle of each block. Elastite contraction joints spaced about 36 feet apart were inserted about 3 inches into the top of the slab, the tops being trimmed off later. These contraction joints are expected to act as precracks only.

It might be emphasized that a firm, smooth subgrade is even more essential with vibrolithic, as the vibration may cause a soft or spongy subgrade to heave and mix with the concrete on the bottom, thus leaving certain weak or thin spots. This condition occurred on one block of our pavement when construction was resumed after a period of prolonged rainfall. Later a few spots the size of a hat broke through under the traffic, but were local and easily repaired. However, an occasional rainfall seems to do no harm to either the subgrade or the finished surface, even though initial set is not yet complete, the belting marks only being washed off.

The property owners, who in Yankton pay for the pavement by assessment, are well pleased with vibrolithic and its smooth riding surface. They are furthermore impressed with the construction method and its tamping effect. Many taxpayers were accustomed, during the period of construction, to watch the machines and feel the vibrations extending from the slab across the curb and to the ground upon which they stood.

In conclusion, we believe that vibrolithic is a forward step in the building of a concrete slab. It is based on the theory that ideal concrete is that which contains the maximum amount of good stone held in place by a sufficient but not excessive amount of 1:2 mortar. Remove from this the excess water, voids and air pockets,

SPREADING GRANITE FROM A GRANITE CAR. FINISHER USED AS STRIKE-OFF.

GRANITE STONE FOR SURFACING PILED IN BAGS. CONCRETING WITH A KOEHRING MIXER

with the whole reduced to a dense monolithic mass, and the result is a pavement calculated to meet the increased loads and impact to which present pavements are subjected.

In this western and middle western section vibrolithic is being used in increasing amount. Throughout Iowa, Illinois, Wisconsin, and in the severe climates of North and South Dakota and Minnesota it has come into general use. Large projects are in course of operation or about to be started at Aberdeen, S. D., and Hibbing, Minn. Much has been laid at Hillsboro, N. D., and in the vicinity of Seattle, Wash. At many points where ordinary concrete has been used vibrolithic has been chosen as simply an improvement over the old method.

Brass and Copper Services

The advantages of the use of brass and copper for water services were set forth by William G. Schneider of the Research Department of the Copper and Brass Research Association in a paper before the March meeting of the New York Section of the American Waterworks Association.

The author stated that the oldest pipes known were made of copper, one believed by Egyptologists to be 5,400 years old having been found at Ghizeh. Brass pipe installed in the Parker House, Boston, in 1856, is still in use, and such pipe has been used to a greater or less extent in connection with the hot water heating for residences; but its use for water services is just beginning.

The great advantage of copper or brass is its freedom from corrosion, either from the water on the inside or from the moist ground on the outside. He stated that because of the tendency of iron services to rust, plumbing contractors consider that a ½-inch brass pipe for cold water work can be substituted for ¾-inch iron, 1-inch brass for 1¼-inch iron, etc.

An advantage that brass pipe has over lead and copper is the possibility of using threaded joints, which are easier to make than wiped joints. In the matter of economy, the author gives as the cost of standard pipe sizes in cents per foot, for 1-inch pipe, 10½c for galvanized steel, 14¾c for genuine wrought iron, 18¼c for galvanized genuine wrought iron, 40c for brass pipe, 44½c for copper pipe and 48c for "A" lead pipe. Owing to the tendency of steel pipe to rust and corrode, however, he considers that the prices of 1½-inch steel and wrought iron pipe should be used, these being 14, 20 and 25c, respectively.

However, the major part of installing plumbing and laying service pipe is the labor. Assuming that a 50-foot service costs $1.50 a foot for labor, this would give the cost of the service, aside from making the connection to the main, vary from $82 for galvanized steel to $85 for brass, $97.25 for copper and $99 for lead. It would not be necessary for the life of the copper pipe to exceed that of the steel pipe by many years to more than make up for the difference in cost.

In addition to these advantages, Mr. Schneider also states that it is possible to eliminate the lead gooseneck by using soft pipe; no red water; there are no inconveniences connected with replacing corroded pipe such as tearing up the pavement and shutting off the water, no inadequate pressure prior to the ultimate failure of the service, and no loss of water due to leaks or broken pipes.

No particular cities were cited as users of brass or copper pipe, but in the information recently collected by "PUBLIC WORKS" through questionnaires we learned of several cities that were using brass or copper pipe, one water company alone having placed an order this year for 125,000 feet of brass pipe for services.

The author gives ten rules for successful use of brass pipe, these being as follows:

1. Use only good brass fittings with threads of standard gauge and size. Do not use iron fittings on a brass pipe job.
2. Cut the pipe with your regular cutters or with a hack saw. Ream the pipe to remove all burrs.
3. Use good dies without broken teeth.
4. One-quarter of an inch per ten feet of length is ample allowance for expansion for hot and cold water lines.
5. When threading keep the pipe as near to the vise as is consistent with easy working.
6. While a lubricant is not absolutely necessary, it facilitates threading.
7. With properly made dies run the die onto the pipe until its surface is just flush with the pipe. When such threaded pipe is screwed home in the fitting no threads will show.
8. Use care in threading and cut the threads down to exactly standard gauge and size.
9. Best appearance in the finished job is obtained by using friction jaws in the vise and friction wrenches. Use care if you screw brass pipe home with a stillson wrench so as not to unduly mar it.
10. With careful threading, good fittings and proper screwing home no pipe "dope" is necessary. Wicking is recommended preferable to a paste of ground red lead and gylcerine, or red lead and linseed oil.

Water Waste in Buffalo

Public Works Commissioner Schwartz of Buffalo has stated that a water waste survey will be carried on this year, especially of leaking fixtures. Where leaking fixtures are reported and the property owner fails to make repairs, the Water Bureau inspectors are turning off the supplies. One territory with a population of 54,589, carefully surveyed by the Pitometer division last fall contained 3,110 leaking fixtures with an estimated waste of 3,000,000 gallons a day and each place where leaks were reported has been visited at least three times since then. Any of these this Spring with unrepaired fixtures will have the water shut off until repairs are made.

Water Waste in Moline

A survey of water waste at Moline, Ill., was begun last October by the Pitometer Company and was completed in March of this year at a

cost to the water department of $4,500. Mayor Sandstrom has reported that a loss of 515,790 gallons a day was located and a large part of it has already been stopped by the water department. The Venturi meter at the pumping station showed an average consumption of 2,500,000 gallons per day with a minimum night rate of 1,723,000. Under-registration was found to be responsible for 27,790 gallons a day. There were no indications found of unauthorized use of water, although a check was made on all large consumers for the purpose of detecting any such unauthorized use, as by use from unmetered fire lines, etc.

Municipal Monopoly in Garbage

There have been many decisions, mostly of local courts, concerning the rights of cities to prevent the collection of garbage by any but municipal or municipally licensed collectors. One of the latest of these is by the Court of Civil Appeals of Texas in the case of the city of Breckenridge vs. McMullen, in which a city ordinance defining garbage and prohibiting the hauling of same by any but a licensed garbage officer of the city or his assistant is held to be within the police power of the city and valid and not to create a monopoly.

Elevating Graders on Highway Work

Economic study of the use of elevating graders and wagons in excavating for highways and other grading work, made by the U. S. Bureau of Public Roads

As a part of the study being made by the Bureau of Public Roads on the various details of road construction, J. L. Harrison, highway engineer of the Bureau, publishes in the April issue of the Bureau's monthly organ, "Public Roads," the result of his study of the use of elevating graders and wagons on more than twenty separate outfits during the 1924 working season.

The graders used were drawn, some by sixteen horses, other by twenty horses, and others by caterpillar tractors. The wagons were apparently all horse-drawn. No mention is made of trains of wagons drawn by tractors, although this has been practiced to a certain extent in the east. The detailed discussion by Mr. Harrison occupies about ten pages and it is possible to give here only a summary of his observations and conclusions.

ELEVATING GRADER FILLING TRACTOR-DRAWN DUMP WAGONS

The elevating grader is a digging and loading mechanism and the wagon a hauling mechanism. Mr. Harrison believes that the wagons should be considered as supplements to the loading mechanism, a sufficient number being employed to keep the grader busy; rather than that the grader should be considered as a device for loading wagons, the latter being the principal feature of the outfit.

Concerning the economy of the grader, he states that an ordinary slip scraper can move about one-fifth of a cubic yard per load, a Fresno about one-third of a cubic yard, and a No. 2 Wheeler about two-fifths of a cubic yard. Two horses and a man are required for either slip or Wheeler and three horses and a man with a Fresno. As compared with this, a standard 1½-yard bottom dump wagon with one man and two horses will carry from 1.2 to 1.4 cubic yards, and a 2-yard wagon with three horses will carry two cubic yards. The function of the grader is to fill these wagons as quickly as possible so as to keep them in continuous operation with as little time as possible spent in anything other than hauling.

The peculiar field of the elevating grader is handling clay and loam in level or rather heavily rolling country. It is not well adapted to work

where slopes are steep and changes in slope abrupt, and it cannot be used to advantage for widening old roads in deep cuts. Neither are those available well adapted to handling sand or working over wet ground. It does not operate satisfactorily where rocks and boulders abound, nor on cut-over lands unless all the larger roots have been removed.

In laying out a procedure for using a grader and wagon combination, the engineer's problem is divided into three parts: 1. The production that this grader can secure; 2. The distance the earth must be hauled; 3. The wagon supply which must be provided in order to move this production over this distance.

GRADER PRODUCTION

The elevating grader is always worked in a loop, usually making a cut down one side of the area, turning at the end and cutting up the other side and then turning back again. No material is ever taken out on the turns, and occasionally the lay of the work permits cutting on only one side of the loop.

While excavating, the grader moves forward digging out material and depositing it in a wagon which moves alongside; then stops while the loaded wagon moves forward and an empty wagon takes its place. The rate at which the grader moves forward while cutting is regulated by that of the wagon which it fills, and the rate at which the material is removed depends upon the cross-section of the cut thrown on to the elevator by the plow or disk. Under favorable conditions this may equal 1 square foot, but with unskilful handling or unfavorable conditions may fall to less than half of this.

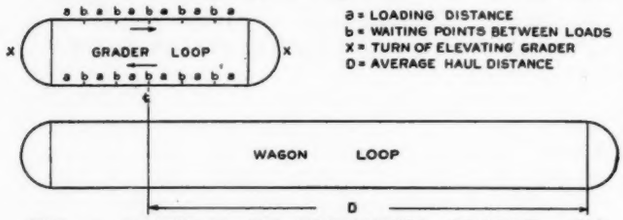

a b a b a b a b a
GRADER LOOP
a b a b a b a b a
X
X
a = LOADING DISTANCE
b = WAITING POINTS BETWEEN LOADS
X = TURN OF ELEVATING GRADER
D = AVERAGE HAUL DISTANCE
WAGON LOOP
D

FIG. 1—DIAGRAM OF ELEVATING GRADER AND WAGON OPERATION.

Typical Stop-Watch Readings on Loading Time, Showing Rapid Loading, for 16-Horse Grader with Eight 2-Horse (1½-Yard) Wagons

Average load, 1.35 cubic yards. Average loading time, 14.9 seconds (343 readings). Average wagon-exchange time, 16 seconds (296 readings). Average grader speed, 3.62 feet per second. Average loading distance, 54 feet.

Loading time down *Seconds* Turn	Loading time up *Seconds* Turn	Loading time down *Seconds* Turn	Loading time up *Seconds* Turn
28	25	15	15
14	15	11	17
12	15	11	13
13	17	11	14
11	16	14	13
11	20	12	17
12		13	23
12		14	

Typical Grader Speeds

Prime mover	Study No.	Number of study periods*	Average grade speed per second Feet
Caterpillar tractor..	13	14	2.9
	17*b*	34	3.3
	18*a*	1	3.1
	18*b*	20	2.8
	20	8	2.9
	23	10	3.0
16-horse team.....	13	18	3.2
	15	9	3.3
	18	5	3.1
	19	22	3.6
	21	3	3.3
	22	6	2.8
20 horse team.....	18	5	3.8
	41	5	3.9

*The study period was generally 1 hour.

Where horse-draw wagons are used, the maximum rate practicable appears to be about 4 feet per second. The discharge from the belt is first placed on the forward end of the box and moved toward the tailboard as the box is filled. This requires that the excavator move at a slightly lower speed than the wagon, and this theoretically is about one-quarter of a foot per second, making the speed of the grader about 3¾ feet per second. If the grader could continue excavating at this rate without stop and always cutting a 1-square-foot cross-section, the output of the machine would be about 500 cubic yards an hour, which may be considered the maximum theoretical capacity. Seventy cubic yards is frequently the average, and few attain a daily average of 100 cubic yards. The difference between the 100 and 500 is caused by losses of one sort or another, and the aim of the contractor should be to reduce these losses to a minimum.

The losses must fall under one of three headings: 1. Failure to maintain the full cross-section while cutting; 2. Failure to maintain full speed while moving; 3. Time losses during the working period.

Full cross-section of bite cannot be maintained in highway excavation. There are a number of reasons for this. If the soil is heavy and comes off the disk in strips or ribbons, a high rate of cutting may be possible; but if it tends to clog the belt, or if the bull wheel which drives the belt slips—a very common condition—the cross-section must be reduced to that which the belt can elevate. Moreover, in many soils, particularly moist clay, the belt fouls badly and as a result tends to slip whenever the load is heavy.

A second cause of reduced cross-section is that the ground is seldom level, while the floor of the cut must end in a level cross-section. This is ordinarily secured by digging a full bite on the high side only and removing a less amount on each trip on the lower side. This might be obviated by taking a wider bite on the lower side than on the upper, but elevating graders are not ordinarily so designed that the width of bite can be changed readily. However, if, instead of following the usual custom, the plow be set for a bite wider than normal, the tractor can be driven a little further from the bank on the high side, thus reducing the width of the bite on this side, and a wide bite may be taken on the low side by driving closer to the bank. This can be done with tractors but is very difficult to accomplish with horses.

There is still the fact that the layers will taper longitudinally, generally running out to nothing at each end. This can not be avoided, but the most skilful operators endeavor to make the bite as uniform and large as possible.

Mr. Harrison states that elevating graders were originally designed for horses, and full advantage of caterpillar traction will not be secured until they are redesigned in some particulars. The weak points are the absolute dependence of the elevating mechanism on the bull wheel, and the tendency of the belt to foul and consequently to slip. The output, therefore, is dependent upon the traction which the bull wheel has on the particular soil over which it is working. The full advantage of the tractor as a prime mover will not be available until the design of the grader is so modified that the power of the tractor can be effectively utilized in forcing the grader to pick up and elevate a full load without regard to soil conditions.

The studies made by the Bureau's engineers show that under average working conditions, a 1½ cubic yard bottom-dump wagon is loaded in about 75 feet, indicating that the amount delivered by the excavator is a little less than 0.5 cubic foot per foot of run. This one feature, therefore reduces the 500 cubic yards per hour theoretical capacity to approximate 250 cubic yards. This loss cannot be regained by efficiency in any other part of the work.

Loading should begin as soon as the belt is clear of the driver, and the wagon should gain enough to bring the belt at the back of the wagon by the time the load is finished, so that the time lost in bringing the following wagon under the belt may be a minimum. The wagon box is ordinarily a little more than 6 feet long and, with the wagon traveling about 4 feet per second, the wagon must move 4 feet further than the grader during the loading period, giving the grader a rate of travel of about 3¾ feet per second. The contractor who operates his elevating grader at a lower speed than this owes a second loss in yardage to this fact. It was found on the jobs inspected that caterpillar tractors hauling graders ordinarily travel about 3 feet per second, thus showing a direct loss of 20% or more in the output.

LOSS OF TIME

The third item of loss is due to loss of time, some of which is unavoidable. The time consumed in making a turn may be taken as about 45 seconds. If the cuts are short, this may amount to 60% of the total time, while if the cuts can be lengthened to a thousand feet, it may be reduced to 6 or 7%. Moreover, in some cases the length of excavation is longer on one side (the uphill side generally) than on the other, and consequently the grader has not only to turn in a half circle, but to travel a certain distance before cutting on the short side begins. With good superintendence it seems reasonable to consider the turning time, including the unproductive run, as 45 seconds, and this can frequently be bettered. The turning time for caterpillar tractors is about the same as for horses, although this is contrary to the general impression. This is due to the fact that the radius of the turn is largely governed by the grader and ground conditions rather than by the flexibility of the prime mover. It is so easy to shift a tractor into high gear that it is surprising to find that no effort is made to do so in making the turns on the majority of jobs. Where the cut is long, a few seconds saved in turning is not so important, but where the cut is short and the turning time is 50 to 75% of the total time, a few seconds saved at each turn totals very high in a day's work.

Effect of Length of Cut on Output and on Relation Between Turning Time and Working Time. Average Management With 1½-Cubic-Yard Wagons

[Loading distance, 75 feet; loading time, 23 seconds; exchange time, 18 seconds; time losses, 10 per cent]

N. B.—A loading loop consists of a run down the cut, a turn, a run up the cut, and a second turn. In developing this table, a half loop—one run and one turn—has been used. By this device the "length of cut" may be compared directly with plans for construction work. The output in loads per hour and the percentage of working time and time used in turning are the same as they would be if the whole loop were used.

Number of loads	Length of cut	Wagon loading time	Wagon exchange time	Grader turning time	Time losses due to breakdowns, rests, etc., 10 per cent	Total time	Loads per hour	Percentage of total time used in turning grader	Percentages of time grader is at work
	Feet	*Sec.*	*Sec.*	*Sec.*	*Sec.*	*Sec.*	*No.*	*P.C.*	*P.C.*
1	75	23	..	45	7	75	48	60.0	30.6
2	150	46	18	45	11	120	60	37.5	38.3
3	225	69	36	45	15	165	65	27.3	41.8
4	300	92	54	45	19	210	69	21.4	43.8
5	375	115	72	45	23	255	71	17.6	45.0
6	450	138	90	45	27	300	72	15.0	46.0
7	525	161	108	45	31	345	73	13.0	46.7
8	600	184	126	45	36	391	74	11.5	47.1
9	675	207	144	45	40	436	74	10.3	47.5
10	750	230	162	45	44	481	75	9.3	47.8
15	1,125	345	252	45	64	706	76	6.4	48.9
20	1,500	460	342	45	85	932	77	4.8	49.4

In calculating the cost of a job using elevating graders, the contractor should pay especial attention to the lengths of cuts and the relative amount of side borrow. With an elevating grader this has entirely different bearing from the problem where Fresnos and wheelers are used.

Another loss of time comes in loading the wagons. This depends chiefly upon the cross-section of bite and speed of grader, but also upon the excavated material that is lost along the edge of the belt and by spilling from the wagon. From such observations as have been made, it appears that this loss may amount to from 5 to 10% of the material taken out by the disk, particularly in light loam and sandy soils.

Another important factor in time losses is the period used in exchanging wagons. This averages about 18 seconds, but was found to vary in different jobs from 9 seconds to 52 seconds. This is the most conspicuous and perhaps most avoidable loss which the contractor encounters in elevating grader work. If the replacement wagon follows the loading wagon with the noses of the

horses against the tailboard of the wagon ahead, the exchange would be theoretically possible in about 4 seconds, the distance from the tailboard of the forward wagon to the back of the replacement driver's seat being about 14 feet and the belt about 3 feet wide.

The most common cause of failure to exchange wagons in five or six seconds is inadequacy of the wagon supply. Many contractors seem to consider that the elevating grader is a piece of equipment for loading a train of wagons, rather than that the grader is the primary tool and the wagon supply should be selected to handle all the material that it can be made to produce.

On the jobs studied it was the rule rather than the exception to find replacement teams walking from 20 to 100 feet behind the wagons they are to replace. Ten seconds exchange time is lost if this distance is 40 feet. Another point is that the load should be finished with the belt over the rear end of the wagon. If it is finished with the belt just back of the driver, two additional seconds are required in making the exchange. Another important point is that the loaded wagon should not turn out at right angles but should drive ahead at an angle so as not to interfere with the replacement wagon instantly taking the loading position; the loaded wagon then standing until the replacement wagon passes.

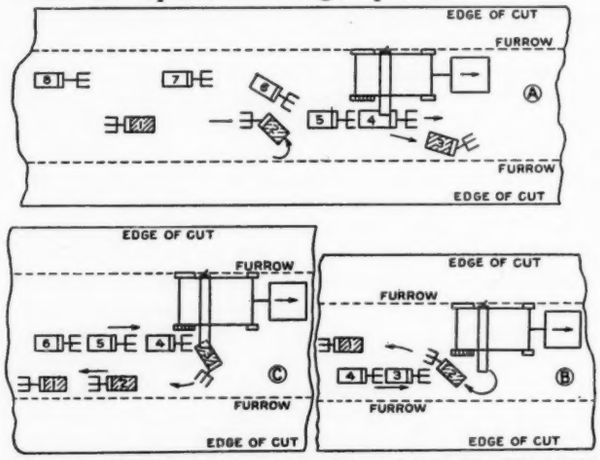


FIG. 2—METHODS OF TURNING LOADED WAGONS AWAY FROM GRADER: A. THE CORRECT METHOD. NO TIME LOST BY GRADER. B. INCORRECT METHOD IN A NARROW CUT. TIME LOST BY GRADER ABOUT 20 SECONDS. C. INCORRECT METHOD IN A WIDE CUT. TIME LOST BY GRADER ABOUT 10 SECONDS.

Reducing the average exchange period is by no means a simple matter. A brief study of Figure 1 will show the reason for this. The loading loop varies in length from one so short that only one load can be taken on each side to a loop 1,000 feet or more in length. The wagon loop also varies in length in the same way. As an illustration, take a loading loop 500 feet in length from which the hauling is in one direction to a point 500 feet below the lower end of the loading loop. (On the jobs studied the average length of cut was almost exactly 450 feet, but averaged as low as 250 feet on two jobs and as high as 600 feet on five.) Under this condition the wagon haul will vary from 500 to 1,000 feet, averaging something over 750 feet. The supply will, therefore, be excessive at some points and deficient at others. In order to obviate this, the contractor should require an empty wagon to trot to position when necessary to place it in position behind the loading wagon when the haul is long. The return pace of the horses can be much reduced when the haul shortens, and with the rest thus obtained by the horses, the occasional trotting will not be injurious to them.

MISCELLANEOUS DELAYS

Other delays may be classified principally under three headings—breakdowns, cleanouts and rests.

Breakdowns occur rather frequently on elevating grader work. The chain drives give the most trouble, the belt gives more or less, and other parts break occasionally. Lack of proper maintenance is the outstanding cause of this trouble. The contractor should buy a new set of chains for the belt drive every spring and should keep on hand spare parts for those parts of the machine which are most apt to break. Where the grader has been used so long that trouble with the elevating mechanism is more or less chronic, it should be discarded and a new one obtained. It is poor economy to continue an old machine in service if this can be done only by accepting a reduction in output. At current prices a substantially built machine can be had for the money secured from the movement of 8,000 to 10,000 cubic yards of material. The loss of as little as 50 or 60 yards a day during the construction season will cover the entire cost of a new machine, and this is a small amount when considered in the light of the heavy reduction in rate of output which attends any reduction in the bite.

Cleaning out around the lower roller stops the outfit many times a day, especially in moist clay soils. Occasionally this must be performed once for every ten or fifteen wagon loads and requires from one to three or four minutes each time. With the present design of grader, this loss of time does not appear to be avoidable.

Another delay where horses are used is that caused by resting the horses, especially in hot weather. The time losses on horse-drawn jobs sometimes exceed 20% in hot weather. It is here that the caterpillar tractor shows its great advantage.

The total of time losses due to breakdowns, cleanouts and resting stops may generally be set at about 5% on caterpillar jobs and from 10 to 20% on horse-drawn jobs, the latter in heavy ground and hot weather.

There are other time losses found on some work. For instance, the time occupied in driving from stable to the point of excavation for the day in question and driving back again at night; stops for watering the horses, etc.

Summing up, Mr. Harrison has found that comparatively few contractors operating elevating graders succeed in averaging much over sixty loads an hour and many do not reach this output. But there is no apparent reason why an efficient contractor should not produce 120 loads

Effect of Various Losses on Elevating Grader Output

	Grader speed 3¾ feet per second			Grader speed 3 feet per second		
	Bite 40 per cent	Bite 50 per cent	Bite 60 per cent*	Bite 40 per cent	Bite 50 per cent†	Bite 60 per cent
Theoretical maximum production of grader at plow, cubic yards per 10-hour day	5,000	5,000	5,000	4,000	4,000	4,000
Rate at which material is delivered by grader while it is loading wagons, cubic yards per 10-hour day	2,000	2,500	3,000	1,600	2,000	2,400
For 1½ cubic yard wagons:						
Portion of grader time spent in loading wagons (based on average length of cut of 450 feet)...per cent	....	....	....	50	45	42
Portion of grader time that can, under good management, be spent in loading wagons (450-foot cut)...per cent	62	60	58	....	....	....
Resulting average production per 10-hour day as now obtained..cubic yds.	....	....	....	800	900	1,010
Average production per 10-hour day reasonably possible with good management...cubic yds.	1,240	1,500	1,740	....	....	....
For 2 cubic yard wagons:						
Portion of grader time spent in loading wagons (based on average length of cut of 450 feet)...per cent	....	....	....	57	53	50
Portion of grader time that can, under good management, be spent in loading wagons (450-foot cut)...per cent	64	63	62	....	....	....
Resulting average, production per 10-hour day...cubic yds.	1,280	1,575	1,860	910	1,060	1,200

*Contractors should endeavor to work in this field.
†Contractors now customarily work in this general field.

an hour. The principal requirements for this are an adequate wagon supply and really competent superintendence.

The contractor figuring on a job should never assume that the conditions will be average conditions. "Many contractors are in financial difficulty today for no other reason than that, in bidding on work of this kind, they have failed to note that projects differ a great deal in this vital element—the average length of cut—and have assumed that the rate of production to which they were accustomed could be maintained, only to find that it could not. It is always necessary to scrutinize this detail with care, but it is doubly necessary in crossing state boundary lines."

Day Labor in Arizona

In 1923 the State Highway Department of Arizona urgently requested the Bureau of Public Roads to permit it to construct by day labor state highway work which received federal aid. The Bureau consented that three projects, Nos. 69, 74 and 77, should be done as test sections. The first of these was begun in October, 1923, at an agreed price of $137,627, this being the basis upon which government aid was to be furnished. No. 74 was agreed upon in September, 1924, for $102,081, and No. 77 in February, 1924, for $80,125.

The Arizona Highway Department recently requested Chief MacDonald to agree to construct by day labor project No. 72-B. Bids for this were opened on January 26th, the lowest being $162,612 and the next lowest $210,196, as compared to the engineer's estimate of $242,318. Replying to this request, Mr. MacDonald stated that in September, 1924, the Bureau of Public Roads had asked the Arizona Department to install a cost accounting system by which the Bureau could be informed of the exact cost of the day labor work being done. So far, however, the Bureau has received no figures from which it could learn the actual cost of the projects already done by the State under day labor construction. "Regular periodical inspections by the Bureau engineers and reports received from these projects convince us, however, that there has already been a considerable loss to the State. . . . It is believed that the excess cost on these projects already amounts to a very large sum." Since the State rejected the two favorable bids received on project 72-B and decided instead to do this work by day labor, and since it is apparent that the cost of the construction will thereby be greatly increased, Mr. MacDonald has recommended to the Secretary that he cancel the approved project statement for this section of the work.

Mr. MacDonald enlarged at some length upon the conditions and his attitude in the matter. Concerning the latter, he stated: "It is an established general principle that day labor construction of highways is not economical. It is possible in specific cases that certain conditions, if existing, may justify a state in undertaking to construct the road at a price not varying materially from the price bid. But in no case is the adoption of the day labor plan as a general policy justifiable from the standpoint of public policy or economy."

Kalispell Waterworks Notes

The Kalispell, Mont. water distribution system contains some kalamein pipe (a type of pipe that was laid quite extensively in the West some years ago) which has been in service for 32 years. Superintendent W. H. Lawrence in his annual report for last year, states that the usefulness of this pipe has about ended and it is being replaced with cast iron as rapidly as possible. He calls attention, however, to the fact that the life of the pipe had been considered to be approximately 25 years and that consequently the present condition of it was not to be wondered at.

Owing to the great growth of the city since the system was first installed, many of the pipes

are too small and new mains are being added or substituted. The new mains are being placed on the side of the street opposite from the present line, leaving the old mains intact until all services have been connected to the new. After the new mains have been laid for a distance of two blocks, they are tested to 130 pounds pressure and then tapped for services.

New hydrants are being set equipped with two hose and one steamer connection, with a 6-inch connection to the main containing a gate valve. The old hydrants are being reset at the center of the block to be used for street and park sprinkling. The old fire hydrants had been fed by small size kalamein pipe. In resetting them, new bottom connections for larger cast-iron pipe were substituted for the old connections, thus adding 40 per cent to their discharge capacity.

While the city was not legally required to change house services to connect with the new pipe, since they were installed and owned by the consumers, the department considered it a moral obligation to do so. Lead services from main to curb cock are required before a street is paved, and property owners who desire lead services installed receive a credit equivalent to the amount the water department would have to pay plumbers for galvanized iron pipe connections.

The 1924 Drought in Connecticut

The year 1924 showed a marked deficiency in rainfall over the entire state of Connecticut. The drought differed from that of 1923 in that it was state-wide rather than confined to certain sections and also that it was of much longer duration.

In Hartford the rainfall for the year was less than in any year in the 57 years records have been kept. In Middletown, the 1924 rainfall closely approached the dry record.

It is customary to total the rainfall for the six months from June to November, because experience has shown that drainage areas furnish smaller percentages of run-off during these months. In 1924, however, the drought was more than seven months in length, and for that reason, the rainfall from June to December is compared with previous years. The Hartford figure for 1924 is considerably lower than any previous record. In New London, Middletown and Bridgeport, the figures are almost as low as in the previous driest years and in New Haven it is necessary to go back to the year 1819 to unearth the remarkably low rainfall of 13.72 inches from June to December.

The figures are borne out by the facts. The public water supply in Shelton became exhausted during the latter part of November, 1924. Pumping from the Housatonic became necessary. Rain then relieved the shortage in Shelton temporarily but in the early part of January, 1925, the public supplies of both Shelton and Derby became exhausted and both supplies were augmented by pumping from the Housatonic river. The emergency supply was chlorinated under the supervision of the State Department of Health, but in order to guard against a possible break-down of the chlorinating equipment, notices to boil the water were issued to the consumers.

The water supply of Farmington was depleted in January, 1925, and it was necessary to pump water from the Pequabuck river. This river receives considerable pollution from the factory wastes and from sewage in Terryville, Bristol, Forestville and Plainville. An emergency chlorinator was installed by the State Department of Health but this was later replaced by a chlorinator secured by the water company. The consumers were notified to boil all water used for drinking purposes.

In Norwich, the officials saw the danger of an impending shortage in the late fall and plans were drawn up and approved for the construction of an emergency pumping station on Trading Cove brook, a rather sparsely settled watershed west of the city. An inspection of the watershed revealed a number of dangerous conditions which were promptly cleaned up by the city officials. In the latter part of December, the water was diverted into the Stony brook supply main, and the Stony brook chlorinator was used to disinfect the water. The issuing of notices to boil water in this case was not deemed necessary owing to the better character of the watershed.

The run-off from thaws and rainfall in the latter part of January, 1925, allowed the abandonment of all the emergency supplies, except in Norwich, where pumping is still necessary to insure filling the reservoirs.

In all of the above named cases, the officials had been warned of the danger of shortage from a prolonged drought, but for financial reasons they had postponed the adoption of needed enlargements. It is expected that steps will soon be taken to improve conditions.

Commenting upon the above facts, the State Department says: "In a monthly bulletin issued just one year ago, this Department called attention to the short duration of the 1923 drought, the fact that it was localized and gave a warning to provide adequate storage or increased drainage areas. It is hoped that the 1924 drought has demonstrated that steps should be taken to improve conditions. Although the time may be far distant when lack of rainfall will deplete supplies with limited drainage areas but large storage, there are a number of such supplies in Connecticut, the officials of which have been advised that enlargements should be made to forestall such an emergency. The risk and inconvenience in allowing a populated community to face a depleted safe water supply is so great that it more than overbalances the serious financial difficulties which the prevention of possible depletion often entails."

Street Lighting in Chicago

As a part of a comprehensive plan that is believed to be one of the most extensive programs for modern residential street lighting ever undertaken by a municipality, Chicago in August of last year began supplanting aerial electric and gas and gasoline lighting units in the residential sections with modern electric lighting units installed on concrete standards. By March 1st of this year it had installed 6500 of the new units covering an area of 11 square miles and 220 miles of streets. The cost was about $1,600,000. During the present year it is expected to spend $2,000,000 more in continuing this work and 6500 of the same lighting units were ordered in March.

After investigating different types as used in various cities, the officials adopted the G. E. Novalux of a special form known as the Chicago type for these new lights. This is similar to the standard Novalux type but the bottom of the globe has greater curvature. The top canopy is an aluminum spinning of natural finish and is designed to support possible future improvements in the form of reflectors or refractors that may become economically available. It will also permit renewing lamps and testing for trouble by the mere removal of the canopy, and it is expected that this will decrease the breakage of glassware, as the globes need not be disturbed. The lamp is equipped with a 250-c.p. incandescent lamp in a rippled glass globe.

The units are mounted on concrete standards designed by the Chicago Department of Gas and Electricity. The standards are 10 feet 9 inches high and are 18 inches wide at the base, which is bolted to a separate foundation.

The lights are installed at intervals of approximately 150 feet in staggered arrangement, the exact locations being such as to insure the lighting of each alley by one of the units, alleys for the removal of garbage, ashes etc. and for entrance to garages being common in the residential sections. The center of the foundation is placed 36 inches from the inside edge of the curb in order that the danger of injury to the posts from motor vehicles may be lessened.

The installation and construction were done by both contract and the city's day labor forces, approximaely 2400 units by the former and 4100 by the latter. The cost of installing the new system is reported to average 80 cents per front foot and the operating cost 11 cents per front foot, as compared with an installation cost of $1.10 and an operating cost of 22½ cents per foot for the installation previous to this one. The expense is borne by the city at large and not by the individual property owners.

NOVALUX FIXTURE EQUIPPED WITH GLOBE AND METAL CANOPY

CHICAGO LIGHT UNIT AND STANDARD

CHICAGO STREET LIGHTED BY NEW TYPE OF LIGHTING UNITS

Burlington Waterworks Notes

Burlington, Vt. has a population of about 23,000, all of which are consumers of the municipal water supply. The consumption last year averaged 59.7 gallons per day per inhabitant and consumer.

There is still in the distribution system some old cement-lined pipe, but Superintendent Henry S. Charron recommends that cast-iron be substituted for this as soon as possible, as breaks in the old pipe occur quite frequently, causing great inconvenience and expense.

A commendable feature of this system is the provision of standpipes for filling sprinkling carts and thus avoiding the necessity of using fire hydrants for this purpose. There are thirty-six of these standpipes 2 inches in diameter.

There are 4681 services in use, of which 4152 are metered. One of the difficulties of this cold climate is the freezing of meters, 67 having been frozen during the year 1924. In addition to these, 1212 were removed and replaced for other reasons.

Sludge Drying and Handling

Utilizing sludge. Digesting activated sludge. Utilization of gas from sludge. Handling sludge. Glass-covered sludge beds.

A paper with the above title was read by Weston Gavett before the New Jersey Sewage Works Association and was the subject of much interesting discussion. Mr. Gavett in a very concise way outlined the general principles involved in tank treatment of sewage and the treatment of the resulting sludge.

Concerning the disposal of sludge, he stated that fresh sludge may be applied directly to the fields as is done at Blackburn, England (although this is not to be recommended), or it may be dumped at sea. But in practically all existing works except activated sludge plants the sludge is digested before further disposition, either in septic tanks, in tanks cut out of service, in Imhoff tanks or in separate sludge digestion tanks. Digestion properly carried out will dewater the sludge to between 80 and 95% moisture, render it inoffensive and readily dryable on sand beds. Objections to sludge digestion are the loss of valuable fertilizing constitutents, and operating difficulties such as foaming and scum formation.

From the beginning of municipal sewerage, effort has been made to find some method of utilizing the solid matter in sewage, use of sludge as fertilizer seeming to be the only one that so far has been considered promising. In Imhoff or settling tanks only a portion of the valuable fertilizing ingredients is collected and much of this is lost during digestion. Although air-dried sludge has been used at Baltimore, Md., as a fertilizer base the common method of using it as fertilizer seems to be to give or sell it to farmers to be used for this purpose. The comparatively large nitrogen and phosphate content of sludge from the activated sludge process has rekindled enthusiasm for the commercial possibilities of drying sludge for sale. Unfortunately activated sludge does not dry readily. Extensive experiments have been conducted at various plants and trials have been made of conditioning by the McLaughlin process, acid, centrifuges, heating dryers, etc. Hatton at Milwaukee has selected conditioning by heating and sulphuric acid and dewatering by Oliver filters and heat dryers.

DIGESTION OF SLUDGE

The treatment of activated sludge by digestion has received little attention. Dallyn has constructed activated sludge plants with sludge digestion tanks in Canada. L. A. B. Wade of the Department of Public Works of New South Wales reported in 1911 using gas from septic tanks to generate lighting current, using a gas engine driven generator. Gas from the Imhoff tanks at Atlanta, Ga., has been collected and used since 1916 for lighting and heating in the engineer's residence and the surrounding grounds. C. E. Leonard in 1922 described the elimination of sewage plant odors by burning the gas at Austin, Tex.

At the present Boonton plant, designed in 1922, gas collectors are provided to collect all gas from the sludge digestion tanks. The gas may be burned in the greenhouses covering the digestion tanks and piping is provided for warming the sludge in the digestion tanks. In a proposed plant designed last year of the activated sludge type sludge will be digested and the gas collected and used to run a gas engine and generate power. This power can be used at times of peak load in the municipal plant. It is estimated that at least 15% of the power required for activation will be obtained from the gas and it is expected that this figure will be greatly exceeded. The digestion tanks are designed not only to digest sludge but also to serve as efficient gas generators as well, and the heat from the engine exhaust and cooling water will be used to warm the sludge pumped to the tank.

Dr. Imhoff, in a paper published in 1923, describes the use of gas from Imhoff tanks, stating that its heating value may be increased by allowing the CO_2 to be absorbed in the tank and giving other practical information on its collection. He gives the amount of gas to be expected as 0.3 cubic foot per capita daily, although published data in this country and experiments give somewhat higher values.

Assuming 0.4 cubic foot per capita daily with 80% methane, 1,000,000 gallons from a population of 10,000 people would give 4,000 cubic feet of gas. From data furnished by A. G. Griese, 1,000 cubic feet of this gas would furnish about 34 k. w. h., using gas engine and generator. At 3½c per k. w. h., 1,000 cubic feet of gas is worth $1.19 and the 4,000 cubic feet per million gallons would be worth $4.76.

The gas may be used for lighting and household use as at Atlanta, for warming the contents of separate sludge digestion tanks and for municipal use as described by Dr. Imhoff, and for power as described by Wade. It also would seem logical to use it for sludge drying.

HANDLING SLUDGE

Mr. Gavett gave some practical suggestions concerning the handling of sludge, stating that proper design of tanks and piping greatly reduces the troubles of the operators. Sludge pipes should be provided with manholes and removable fittings at bends so that any section may be rodded. Water connections for flushing the pipes are a great convenience. Where sludge is to be dried on sand beds, it is preferable to discharge from the tanks by gravity rather than pump, to avoid breaking up the gas bubbles. For the same reason sludge valves should be opened gradually and as little as possible. Sludge, being thick, flows slowly and should be allowed to ease its way out, to prevent the water above the sludge breaking through.

A good sludge pump is an essential part of a plant. Even with gravity discharge of sludge, it is useful for transferring sludge from one tank to another and for pumping out manholes. If a centrifugal pump is used, it should be of a type designed for handling sludge. It is well to avoid suction lift with a centrifugal pumps, as the gas in the sludge may break the suction. Sludge pumps of the closed diaphragm type are well adapted to sewage plant work. They will lift the sewage without priming and force it against some head, will handle thick sludge and sand, and the valves, which are of the ball type, are accessible. Pumps of this type known as the "mud hog" and the "humdinger" are successfully used at the plants at Plainfield, Madison-Chatham, and Bogota.

The lack of suitable pumping equipment is often the cause of poor results obtained from plants. Engineers are sometimes criticized for poor results that were due to the tank filling with sludge, and the operator can hardly be blamed for not wanting to shovel this out. Mr. Downs has always preached that the engineer should include, in the specifications for a new plant, service pumps and other needed operating equipment. Such items would add very slightly to the first cost but play an important part in the plant operation. It is easier to get such equipment when the plant is constructed than for the operator to requisition a small item after construction. Such equipment may include pumps, tools, hose, recording gauges, meteorological instruments, laboratory supplies, etc.

GLASS-COVERED BEDS

Referring to the drying of sludge on sand beds or fields, Mr. Gavett advanced arguments in favor of making drying beds independent of weather conditions by covering them with glass like hothouses. "A glass-covered bed greatly improves the appearance of the plant and reduces the possibility of odor when sludge is discharged. The glass covering will also materially increase the temperature of the sludge bed. Wagenhals, Theriault and Hommon state that the idea of covering the beds with a glass structure such as a greenhouse, to protect drying sludge from rain and to permit of all-year operation, was originated at the Cleveland sewage testing station in 1913. The results there indicated that, for local conditions, one square foot of glass-covered beds was equivalent to two square feet of open beds. Glass-covered beds are used at Canton and Alliance, Ohio, and the new Park Avenue plant of the North Shore Sanitary District of Chicago. The largest installation of this kind is at the Boonton plant of the Rockaway Valley trunk sewer, where the glass-covered bed is 79 feet 4 inches by 150 feet 4 inches. Anyone who questions the improved appearance that such a bed gives a plant should visit the Boonton works."

It has been found in most places in this country that for drying Imhoff or digested sludge an area of one square foot per capita should be provided, which apparently could be reduced to ½ square foot for glass-covered beds.

Lime in Sewage Treatment*

Result of investigations by Maryland Bureau of Sanitary Engineering to determine effect of lime treatment on odors from sludge and its drying qualities

By T. C. Schaetzle†

Present Plant Operation. At the time of this investigation of the sludge problem at the Hagerstown, Maryland, Sewage Treatment Works, approximately 1,600,000 gallons of sewage were being treated. After passing through Dorrco screens, the sewage was settled in a Dorr clarifier and then discharged into Antietam creek. The accumulated sludge was removed daily by pumping into a temporary tank where calcium oxide was added to it. This tank was equipped with a revolving stirring device to obtain a thorough mixture of lime and raw sludge. The tank was placed sufficiently high to allow a sludge wagon to be drawn under it for the discharge of the lime-treated sludge into it. The material was then spread, in a thin layer, on the farm lands adjacent to the sewage works owned by the city of Hagerstown. The sludge removed daily from the Dorr clarifiers amounts to about 1800 gallons with a water content of approximately 92.7 percent. This quantity produces three sludge tanks of material, to each of which is added 100 pounds of hydrated lime.

Proposed Treatment. It is proposed by the Hagerstown Sewerage Commission to treat the raw sludge with lime in the manner outlined. This treatment was advised by C. Lee Peck, consulting engineer. The lime-treated material is to be disposed of either upon farm lands or upon sand beds, after which it is to be sold as a fertilizer.

Scope of Investigation. This investigation was made to determine the effect of lime treatment upon the odors which might emanate from the sludge and upon the drying qualities of this material. From field observations, it was apparent that the obnoxious and strong odor

*Contribution from Bureau of Sanitary Engineering. Maryland State Department of Health, Abel Wolman, Chief Engineer.

†Senior Assistant Sanitary Engineer, Bureau of Sanitary Engineering.

usually produced by raw sludge was changed almost immediately after the lime had been thoroughly stirred with the undigested material. The lime produced a rather pasty substance which seemed to give up its water slowly. This latter condition is shown by the fact that lime-treated sludge placed upon sand beds for ten days had lost only sufficient water to reduce its moisture content from approximately 90.7 percent to 78.3 percent. Further drying for an additional fifteen days reduced the moisture content only two percent more. These facts are shown in the table. Observations indicate that the major portion of water lost is through evaporation and that little, if any, filtration takes place.

ODORS

To obtain more information as to the permanency of the change in odor caused by the addition of lime, a sample of lime-treated sludge was obtained from each of the three tanks produced on October 9, 1924. In addition, a composite sample of raw sludge was also taken. These samples were placed in Mason jars and returned to the Engineering Bureau's office for observation. The raw sludge was raised to the surface by gas action, whereas the lime-treated material remained in the bottom of the jars. The usual putrid odor was produced by the raw sludge at the time it was taken and grew worse after being held two days. The lime-treated sludge had a strong limey or soapy odor which was fairly intense, but was not disagreeable to the writer at the time it was obtained. Observations of the odor emanating from the lime-treated sludge were made after the elapse of 1, 2, 30, 51, 55, 79 and 88 days. The nature of the odor was practically the same for the first 30 days, after which time a rather strong ammonia odor was observed. This persisted until the time of the last observation but seemed to be somewhat less in intensity than when it was first noticed.

STERILITY

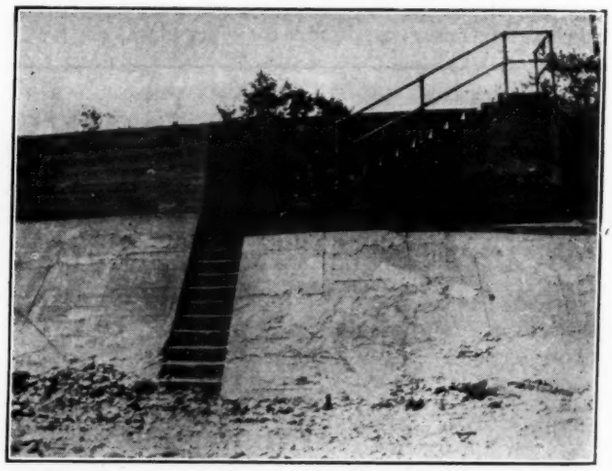
It was thought that the change in odor might not be permanent if certain putrefying bacteria were able to grow at some time after the application of lime. In order to ascertain the degree of sterilization brought about by lime treatment, bacteriological analyses were made of samples of sludge taken on October 9. Table 1 which is a summary of the results obtained, indicates that a great proportion of bacteria were killed by the calcium oxide, a reduction of 93 percent in the total count having taken place.

To learn if prolonged holding on the sludge drying beds might allow the inhibited forms of bacteria to grow, a sample of lime-treated sand-bed sludge was analyzed. This sample showed the presence of 60 bacteria per cubic centimeter or approximately 240 bacteria per gram of dried material and no colon, with a sludge moisture content estimated at 75 per cent.

(To be continued)

Steps in River Wall

Many streams, especially in the west and southwest, while carrying considerable amounts of water at times, are for nine or more months of the year perfectly dry. Where these are carried through cities, the expense of a bridge at every street crossing may be avoided by using the bed of the stream instead at unimportant crossings. The illustration shows a concrete wall erected along one of such rivers in Los Angeles, Calif. Traffic at this point did not warrant the expense of a bridge, so a flight of steps was built in each of the two walls in line with streets every few hundred feet for the use of pedestrians, thus enabling them to cross without walking several blocks to the nearest bridge.



STEPS IN CONCRETE RIVER WALL TO PERMIT CROSSING IN DRY WEATHER

Table 1—Moisture Content and Bacterial Counts of Untreated and Lime Treated Sludge; Hagerstown, Md.

Date	Sample	Percentage Moisture	Total Bacteria per gram of dry sludge at 37°C.	Colon per gram of dry sludge
10/9/24	Raw tank sludge	92.14	450,000	12,700,000
10/9/24	Lime-treated tank sludge	90.63	53,000	110
10/9/24	Lime-treated tank sludge	89.87	19,500	1,000
10/9/24	Raw tank sludge	93.23	590,000	14,700,000
10/9/24	Lime-treated tank sludge	91.56	35,500	12
10/22/24	Lime-treated sand bed sludge	75.00*	240	0
10/9/24	Lime-treated sand bed sludge	78.28 (Placed 9/29—removed 10/9—interval 10 days).		
10/9/24	Lime-treated sand bed sludge	76.28 (Placed 9/13 and 14—removed 10/9—interval 25-26 days).		

*Estimated.

PUBLIC WORKS

Published Monthly
at 243 W. 39th St., New York, N. Y.

S. W. HUME, President J. T. MORRIS, Treasurer

Subscription Rates
United States and Possessions, Mexico and Cuba $3.00 year
All other countries ..... $4.00 year
Single copies, 35 cents each

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Western Office: Monadnock Block, Chicago

A. PRESCOTT FOLWELL, Editor

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Highway Equipment for Counties

It has been only a very few years since a split log drag was considered the only equipment, other than wheelbarrow, pick and shovel, that was needed for maintaining county roads in all but three or four of the eastern States. The tabulated data on road maintenance in this issue shows how far the counties have progressed beyond that standard. One Alabama county reports that its maintenance gangs are equipped with plow, wheelers, graders, tractor, scarifier, finisher and drags, as well as shovels and other small tools. The three maintenance gangs in an Iowa county use a crushing and screening plant, four trucks, two blade graders, six wheel scrapers and two plows; while the patrolmen are supplied with patrol grader, drag, slip, scythe, mower, shovel, etc. About ninety per cent of all the patrolmen and gangs have graders, while more than half the gangs have tractors or trucks or both. A reference to the table will show the use by a number of counties of scarifiers, rollers, gravel crushers, screens and loaders, concrete mixers, tar kettles, heaters and other appliances.

For each section of the country, according to its climate, topography, soil, available surfacing materials and traffic, there are appliances particularly suitable to its needs, and maintenance officials, in order to select these wisely, should familiarize themselves with what the various manufacturers have to offer.

Test Roads and Actual Service

In a recent statement prepared by the secretary of the National Paving Brick Manufacturers Association he says: "Putting down a test road and riding it to destruction in less than two years is one thing. A pavement in actual use from 25 to 35 years, subject—as such a test road is not—to the damaging influences of natural agencies for this period, as well as the heaviest possible traffic, is another." This statement calls attention to an important feature which, while it is no doubt realized by those conducting the investigations, may be overlooked by highway officials in reading reports of the tests and conclusions therefrom. The two natural agencies most instrumental in producing deterioration in highways are rain and frost; although the heat of the sun, wind and certain other natural phenomena produce more or less of an effect under certain conditions.

The effect of frost is exerted most generally through the heaving of the subgrade and the resulting cracking of the base or the pavement itself. Some bases are sufficiently flexible to withstand a moderate amount of heaving followed by settling without serious rupture, while others such as concrete are apt to be permanently and sometimes quite seriously injured thereby. Also, some wearing surfaces can withstand this distortion without experiencing serious injury while others cannot. Some bituminous materials are rendered much softer by high temperatures than others and would, therefore, seem to be less suitable than others in southern

climates for use as a binder in wearing surfaces or a filler in brick or block pavements. Some pavements may withstand satisfactorily a traffic test calculated to demonstrate their suitability for light travelled roads, but suffer seriously from heavy rains, especially where the grades are at all steep.

The reference just made to grades suggests also that until within the past few months most, if not all, of the test roads have been on practically level grades, and there are several features connected with safety and durability on steep grades concerning which no information is furnished by the tests carried on.

All of these matters are important and the information obtained from the tests is not complete without additional knowledge concerning them also. The effects of natural phenomena exerted through a long series of seasons can best be studied on roads which have been in actual service for a number of years. Some of the phenomena connected with grades are in a way to be studied by test roads recently constructed or about to be constructed.

The point we wish to bring out is that investigators as well as engineers and highway officials should not overlook the fact that the test roads so far built and studied tell only a part of the story, and that a pavement which has best withstood the conditions of such a test is not necessarily the one most suitable for actual long-time service in all localities.

American Water Works Convention

The forty-fifth Annual Convention of the American Water Works Association, held at Louisville, Kentucky on April 27th-May 1st, was generally considered by the active members present to have been a most successful one. The headquarters at the Brown Hotel were ample and conveniently located and were unusually free from disturbing noises, either inside or outside of the building.

About 450 active members and 200 associate members registered, while there were three hundred or more guests accompanying the members, about half of which were ladies.

The outstanding feature of the convention, which was put prominently forward at all of the meetings, except possibly some of those of the sections, was the preparation of the manual of American Water Works, which the Standardization Council expects to have ready for distribution this Fall. Secondary only to this was the matter of Fire Prevention, and fully three-quarters of the time of the convention in the assembly hall was taken up with the discussion of these two subjects.

The general subject of the manual, however, included the entire water works field, since the attention to this subject in the Convention took the form, to a large extent, of the presentation of synopses of the various branches of water works practice with a view to obtaining criticism, supplementary information and other forms of assistance from the membership at large to aid in putting the material for the manual into a reasonably satisfactory shape. The Chairman of the Standardization Council, George W. Fuller, stated that it could not be and was not expected that the first edition of the manual would be entirely satisfactory or permanent in form, but that it was anticipated that a second edition would be necessary in, perhaps, two or three years, during which time suggestions and constructive criticisms would be asked from members of the Society. Mr. Fuller and the various committees among whom he had apportioned the work of preparing the manual were busy from early morning to early next morning every day of the week trying to work the material of their respective subjects into more satisfactory shape, one of the aims being to reduce it from twenty-five to fifty per cent in volume. Arrangements had been made with a publisher of technical books to print and handle the manual and it had been agreed with this publisher that the size should, if possible, be limited to about 550 pages.

The business of the Convention consisted of the adoption of several amendments to the Constitution, providing among other things for admission of other water works associations into affiliation; cancelling the portions of the Constitution referring to a secretary emeritus, (these no longer having any significance since the death of Mr. Diven); providing that the candidates for President, Vice-President and Treasurer must have been for at least two years on the executive committee or a member of certain of the standing committees; putting in more definite and practical form the procedure for selecting members of the nominating committee; providing for an administrative committee and publication committee; providing that convention invitations, to be considered, must be received in writing several weeks before the conventon; making some minor changes with respect to the funds allotted to the local sections; and providing for regional meetings to be held jointly by several sections. A budget was presented totaling $35,000 and was adopted. Five members were elected to honorary membership, these being: William B. Bull, of Peoria, Illinois, J. P. Donahue of Colfax, Iowa, Dow R. Gwinn of Terre Haute, Indiana, J. Waldo Smith of New York City, and Prof. W. P. Mason of Troy, New York.

The Diven Memorial Committee recommended as a form of memorial, a Diven bronze medal to be awarded annually to the active member who had rendered the greatest service to the association during the previous year by contributions to the journal or to meetings of the association and by advance of the water works profession.

The nominees of the nominating committee were elected without opposition, these being for president, Harry F. Huy, of Buffalo; vice-president, George W. Batchelder of Worcester, Mass.; treasurer, W. W. Brush of New York City. At the end of the convention the Executive Committee announced that they had chosen Beekman C. Little, superintendent of waterworks at Rochester, N. Y., as secretary, retaining as assistant secretary, W. M. Niesley, who held this position under Secretary Diven and had been acting secretary since his death.

The several technical divisions elected chairmen

as follows: Plant Management and Operation, James E. Gibson, Charleston, S. C.; Fire Protection, Nicholas S. Hill, Jr., of New York City, N. Y.; Water Purification, James W. Armstrong, Baltimore, Md. The last named division is that formerly known as the Chemical and Bacteriological. The nominating committee selected at this Convention announced as the candidates for 1926-27, George W. Batchelder for president and E. E. Wall for vice-president.

The Secretary announced that the membership on March 31st of this year was 2158, a net gain of 222 for the year.

Buffalo was chosen for the 1926 Convention.

While the active members had little but praise for the convention, as much cannot be said for the associate members. Unfortunately, space apparently could not be found in the Brown Hotel for the exhibits, and these were placed on the second floor of a building across the street from the hotel. The weather was showery a large part of the time, which discouraged crossing from one building to the other and very few of the active members—those for whom the associate members had gone to the trouble and expense of preparing the exhibits—took the trouble to visit them, although officers of the society repeatedly requested from the platform that the members take the opportunity to do so and curtailed two of the sessions by about an hour and requested the members to go in a body to the Exhibit Hall. This was unfortunate for the active as well as for the associate members, since the exhibit was even more instructive than ordinarily and was excellently arranged and must have well repaid the few who visited it. This was so thoroughly recognized by the leading active members of the Society that there is no question that care will be taken to make much more satisfactory arrangements at Buffalo next year.

The technical sessions were well attended and made interesting by an unusual amount of discussion. A brief narrative of these sessions will be found in the section of this issue devoted to societies, and several of the papers will be published in later issues.

Winter Use of Maintenance Force

The annual report of the Rhode Island Board of Public Roads says:

"As the fiscal year closed, our maintenance forces had been reduced to the minimum manpower which we have found it necessary to carry through the winter as a nucleus to carry out our snow-removal program. These men are kept busy during the winter months between periods of snow removal in placing temporary patches over cuts made in our hard-surfaced roads during the winter by public utilities, the patching of holes in our cheaper roads, the cutting of brush along the roadsides, the painting of guard railing, the repair of equipment and the hauling and storing of materials for future maintenance. The effective use made of these few maintenance men whom it is necessary to keep in our employ throughout the winter if we are to carry out successfully our program of snow removal makes the cost of snow removal comparatively low."

Continuous Pouring of Concrete Road

In constructing Project No. 537-B of the North Carolina State highway system, in and near Greensboro, the Zieglar & Dalton Construction Co., of Greensboro, introduced the unusual feature of working one mixer night and day for several weeks, using two shifts, with but a few minutes between the stopping of one and the starting of the other. Because of this, no construction joints were introduced in one continuous stretch of 5,226 lineal feet. This one mixer poured 16,511 feet of 18-ft. pavement, 8⅞ inches thick in 17 days.

The reason for the double shift was that the contractor started working two mixers and crews, but work on one of them was stopped by delay by the city in getting water and sewer pipe laid preparatory for paving. Rather than lay off the experienced crew of this mixer, the contractor moved it over to the other mixer.

The whole contract of 12 miles was poured in four months and eleven days. There were but four material stock piles on the twelve-mile stretch. Bins holding sand and stone were used and loaded by Koehring cranes. Two five-bag batch trucks were used to haul and load the 21E Koehring mixer.

Testing Materials for Rhode Island Roads

The State Board of Public Roads of Rhode Island makes a practice of locating and testing materials suitable for road building purposes, generally in connection with proposed contracts. The information obtained is issued in pamphlet form to prospective bidders, who are thus aided in planning a tentative program for carrying out the work to the best advantage. This has resulted in closer competition and lower costs to the state.

A material survey for a contemplated contract consists of the locating and testing of all known sources of supply of mineral aggregate located within reasonable distance of the job. The final selection of the type of pavement or foundation often depends on the data obtained from the material survey.

In examining sand or gravel banks, the average depth of test holes is six or seven feet; or, if there is a working face on the bank, greater depths are obtained by stepping down. Fifty-pound samples are run through coarse screens in the field and that passing the half inch screen is sent to the laboratory and run through the colorimetric, elutriation and screen analysis tests; the screens used covering specifications for bituminous, cement concrete and gravel pavements and foundations.

The information is furnished to the contractors interested, accompanied by a sketch map of the vicinity of the proposed contract. On this map are shown the gravel and sand banks, designated by numbers by which they are re-

ferred to in the pamphlet, and signs giving these numbers are posted at the locations themselves so that the contractor can locate any bank without difficulty or mistake. The contractor is supposed to supplement this survey by one of his own, but it at least saves him from unnecessarily investigating certain banks or pits the material from which will not pass the specifications.

State and County Highway Statistics

Amount of money spent last year and available this for highway work by states and counties; also the kinds of improvement carried out and the cost of each. Amounts spent for maintenance of each kind of road by several hundred counties, and equipment of patrolmen and maintenance gangs

In the following tables are tabulated data furnished in reply to our questionnaires by State and County highway officials, giving, for each state, the amount of "Federal Aid spent by the state in 1924," the amount "furnished by the state for highway work," and that "furnished by counties, towns, or other subdivisions of the state;" also the amounts available for 1925. For the counties the sums are those "spent on highways in your county in 1924, under county or state supervision, from county appropriations; from state appropriations; from Federal appropriations; from other appropriations."

There are also given the miles constructed during 1924 of each kind of road improvement and the cost thereof, and the total mileage in the county at the end of that year.

In a number of states, like Connecticut, the counties have nothing whatever to do with either construction, maintenance or payment for highway work; while in others very few take any part in such work, only three or four in Pennsylvania (Allegheny and Westmoreland among them) having any road organization at all, the others spending all funds through the State Department of Highways. Several states, therefore, are not represented at all in the tables of county statistics.

In addition to the tabulated data, information concerning dust layers and culverts was obtained which it seemed preferable to present in the form of summaries, which are given below:

USE OF DUST LAYERS

Very little attention is paid to the laying of dust on the highways by the great majority of counties except insofar as the construction of improved road surfaces has this effect. Of the several hundred counties returning our questionnaire only forty-four reported using any material for this purpose. Of these twenty-five use oil, two specifying asphalt and two crude oil; thirteen use calcium chloride (two reported that they are trying it out); and six use water.

Those reporting the use of oil are: Ashley, Arkansas; Fresno and Kings, California; Menard, Sangamon, Scott and Whiteside, Illinois; Decatur and Scott, Iowa; Garrard, Rockcastle (on State and Federal Roads), and Woodford (surface treatment), Kentucky; Garrett, Md.; Luce, Michigan (asphalt); Grenada and Harrison, Mississippi; Toole, Montana; Madison and Thompkins (asphalt), New York; Clark, Clinton, Fayette (surface treatment), Madison and Sandusky, Ohio; and Okmulgee, Oklahoma.

Calcium Chloride is used in Cerro Gordo, Dubuque, and Winneshick, Iowa; Alger, Chippewa, Genessee, Hillsdale, Jackson, Livingston and Shiawassee, Michigan; Le Sueur, Minn.; Clinton and Warren, Ohio.

Water is used by Napa and Sutter, California; Rio Grande, Colorado; Evans, Georgia; Elke (in towns) Nevada, and Deschutes, Oregon.

MATERIALS USED FOR CULVERTS

Among the questions asked the various counties was one relative to materials used for culverts. It was assumed that practically all of the counties used concrete for at least the larger culverts, although a few reported that no concrete was used. On the other hand thirty-two counties reported using concrete only, these including, 1 in Florida, 2 in Illinois, 1 in Indiana, 8 in Iowa, 4 in Kansas, 1 in Kentucky, 1 in Michigan, 4 in Minnesota, 1 in Mississippi, 1 in Missouri, 1 in New York, 5 in Ohio and 2 in Oklahoma.

More than two-thirds of those reporting use corrugated iron for culverts, about five per cent use cast iron, seven per cent vitrified pipe and five and one-half per cent use wood. Two of the last reported using creosoted wood and it is to be presumed that some of the others practice this also. One North Carolina county reports building stone culverts.

Of the counties using corrugated iron, 1 is in Alabama, 1 in Arizona, 1 in Arkansas, 5 in California, 3 in Colorado, 1 in Connecticut, 3 in Florida, 3 in Georgia, 1 in Idaho, 3 in Illinois, 7 in Indiana, 21 in Iowa, 10 in Kansas, 5 in Kentucky, 5 in Michigan, 27 in Minnesota, 3 in Mississippi, 3 in Missouri, 5 in Montana, 3 in Nebraska, 1 in Nevada, 2 in North Carolina, 9 in North Dakota, 9 in Ohio, 3 in Oregon.

Cast iron was reported by 2 counties in Florida, 1 each in Georgia, Idaho, Indiana and North Carolina, 3 in Ohio.

Vitrified pipe was reported by one county in each of the states of Florida, Georgia, Louisiana, Michigan and Oregon, 2 in Iowa and Mississippi, and 5 in Ohio.

Wood was reported by one county in Arizona, 2 in Arkansas, 1 in Iowa, 2 in Kansas, 1 in Louisiana, 2 in Montana, 1 in Nevada, and 1 in North Carolina.

Amount Spent on Highways in 1924

County	Amount spent on highways in 1924, under County or State supervision, from: County appropriations	State appropriations	Federal appropriations	Other appropriations	Total amount available for 1925
Alabama:					
Coosa	$35,000	....	....	....	$112,000
Arizona:					
Greenlee	45,687	....	....	....	101,234
Maricopa	....	....	....	....	400,000
Arkansas:					
Ashley	20,000	$60,000	....	....	200,000
Clay	....	....	....	....	15,000
Desha	....	....	....	....	160,000
Polk	35,000	....	....	....	....
California:					
Butte	....	....	....	....	173,000
Fresno	667,800	....	....	....	None
Kings	....	....	....	....	140,000
Napa	....	....	....	....	150,000
San Joaquin	352,368	....	....	....	....
Sutter	470,000	100,000	None	None	100,000
Colorado:					
Clear Creek	27,500	32,500	$8,000	....	66,341
Gunnison	....	....	....	....	180,000
Rio Grande	38,915	14,069	25,000	....	50,000
Connecticut:					
Windham (town)	....	....	....	$3,652b	3,750
Florida:					
Bradford	550,000	111,000	....	....	45,000
Escambia	....	....	....	....	700,000
Jackson	60,000	....	....	....	....
Madison	40,000	....	....	100,000	215,000
St. Johns	200,000	75,000	....	....	1,280,000
Saint Lucie	187,000	318,000	318,000	....	170,000
Santa Rosa	61,000	None	15,000	....	50,000
Georgia:					
Bacon	6,000	6,000	5,000	....	....
Clarke	50,000	4,000	50,000	5,000	150,000
Evans	5,000	2,500	None	None	7,500
Lee	125,000	....	....	....	....
Monroe	7,500	7,500	20,000	None	100,000
Union	....	50,000	50,000	....	....
Upson	....	....	98,800	36,000	4,000
Wilkes	104,900	....	104,900	....	65,000
Idaho:					
Boise	20,000	2,500	40,000	....	101,000
Canyon	75,000	....	....	....	95,000
Illinois:					
McHenry	60,000	....	....	120,000c	....
Menard	20,000	None	None	20,000	140,000
Sangamon	100,000	....	....	....	110,000
Scott	55,000	....	None	None	50,000
Whiteside	31,714	....	....	....	....
Indiana:					
Bartholomew	50,000	6,000	....	....	80,000
Boone	94,810	25,000	....	....	125,000
De Kalb	76,000	....	....	30,000c	80,000
Du Bois	227,000	None	None	9,500	43,000
Howard	146,382	....	....	196,578	....
Jackson	180,000	None	None	....	120,000
Monroe	150,000	100,000	....	50,000c	....
Newton	60,000	3,000	None	None	....
Iowa:					
Appanoose	200,000	....	....	....	....
Buena Vista	65,000	80,000	20,000	....	155,000
Casa	100,000	90,000	....	....	180,000
Cedar	95,740	98,000	....	....	193,000
Cerro Gordo	150,000	30,000	....	....	185,000

County	Amount spent on highways in 1924, under County or State supervision, from: County appropriations	State appropriations	Federal appropriations	Other appropriations	Total amount available for 1925
Iowa (Continued)					
Chickasaw	78,000	80,000	....	....	160,000
Clayton	125,000	230,000	20,000	None	225,000
Crawford	....	....	....	....	250,000
Dallas	262,700	70,000	20,000	....	375,000
Decatur	29,679	$6,183	....	....	117,09?
Dubuque	100,000	....	....	60,000	100,000
Emmet	37,497	129,629	....	....	102,000
Fayette	....	....	....	....	178,000
Grundy	100,000	90,000	....	....	180,000
Guthrie	140,000	30,000	None	None	120,000
Hamilton	40,000	90,000	20,000	....	140,000
Harrison	250,000	180,000	20,000	50,000	200,000
Howard	56,000	75,000	....	....	136,000
Jasper	40,315	35,000	....	....	170,000
Johnson	48,000	105,000	None	None	239,000
Jones	28,000	80,000	20,000	65,000	125,000• / 65,000†
Kossuth	54,000	130,000	38,000	None	220,000
Lyon	44,000	100,000	....	....	130,000
Mills	24,000	25,000	....	51,000	10,000
Muscatine	43,726	43,605	14,698	23,094	98,166
O'Brien	102,000	50,000	....	....	175,000
Palo Alto	51,000	70,000	....	....	165,000
Plymouth	500,000	230,000	35,000	135,000	175,000
Sac	109,235	57,084	....	....	....
Scott	56,345e	42,450e	42,000	....	900,000
Tama	41,290	28,000a	....	....	90,000
Van Buren	50,000	50,000	....	....	100,000
Winneshiek	31,600	40,000a	....	....	150,000
Kansas:					
Butler	497,921	....	191,608	....	750,000
Comanche	....	12,000	....	....	80,000
Chase	40,418	None	None	None	50,000
Crawford	136,758	68,508	....	18,229	200,000
Ellis	26,000	....	....	....	109,000
Ellsworth	25,257	3,263	....	....	....
Finney	57,000	13,000	....	....	200,000
Kingman	....	None	None	None	69,000
Meads	35,663	....	....	....	60,000
Morton	8,000	None	None	9,000c	20,000
Pratt	31,000	None	None	None	112,000
Reno	125,000	5,000	25,000	....	150,000
Republic	100,000	None	None	None	80,000
Sheridan	42,589	7,478	14,648	30,602	80,000
Smith	73,000	None	20,000	None	100,000
Wabaunsee	....	....	....	....	200,000
Kentucky:					
Boyle	60,573	....	None	None	50,000
Fleming	32,000	None	None	....	....
Garrard	47,000	50,000	....	....	30,000
Grayson	....	....	....	....	20,000d
Jackson	8,250	None	None	None	....
Marshall	....	....	....	....	17,000
Perry	100,000	100,000	50,000	None	400,000
Rockcastle	13,800	81,000	20,000	30,000	126,000
Rowan	8,000	....	....	....	....
Webster	....	120,000	120,000	45,000	45,000d
Woodford	103,000	33,000	None	None	80,000
Louisiana:					
Acadia	250,000	95,000	90,000	None	100,000d
East Feliciana	145,000	....	....	....	400,000
Vermilion	500,000	None	None	None	130,000
Vernon	570,000	100,000	....	....	567,000

Amount Spent on Highways in 1924

County	Amount spent on highways in 1924, under County or State supervision, from: County appropriations	State appropriations	Federal appropriations	Other appropriations	Total amount available for 1925
Michigan:					
Alger	67,000	70,000	....	....	90,000
Chippewa	85,000	234,000	....	30,000	200,000
Genesee	914,622	108,282	216,564	....	810,000
Hillsdale	197,120	136,942	None	None	250,000
Jackson	135,000	242,000	....	....	....
Keweenaw	30,000	28,000	....	....	72,000
Lake	10,000	14,000	....	....	20,000
Livingston	....	....	....	....	80,000
Luce	23,000	83,000	....	....	140,000
Shiawassee	19,000	90,000	None	None	Not known
Minnesota:					
Aitkin	78,652	5,000	....	....	83,000
Blue Earth	173,642	....	....	....	157,896
Brown	82,256	23,460	....	90,966b	105,000
Cass	25,000	30,000	....	....	....
Cook	38,000	32,000	10,000	....	68,000
Cottonwood	70,000	20,000	....	....	70,000
Dakota	135,000	22,700	....	78,925f	142,700
Dodge	73,319	20,000	....	50,000	....
Goodhue	196,977	24,100	....	....	175,000
Grant	31,455	20,000	None	None	50,000
Houston	50,000	20,000	....	60,000b	....
Jackson	140,000	125,000	50,000	....	150,000
Lac Qui Parle	65,000	20,000	....	....	85,000
Le Sueur	294,640	25,000	....	....	75,000
Lincoln	40,000	20,000	None	None	53,000
Mahnomen	15,000	20,000	....	....	25,000
Marshall	89,000	20,000	None	....	40,000
Martin	129,950	22,350	....	....	125,000
Murray	145,881	....	....	....	70,000
Norman	45,000	20,000	....	....	50,000
Otter Tail	200,000	29,900	....	....	206,000
Pennington	30,000	20,000	....	....	70,000
Pikestone	53,000	20,000	....	....	60,000
Red Lake	24,255	20,000	....	....	46,000
Redwood	85,000	15,000	....	5,000	110,000
Rock	93,718	....	....	....	60,000
Sibley	135,868	22,826	....	23,000	106,000
Stearns	100,000	200,000	200,000	....	135,000
Swift	100,000	20,000	....	....	80,000
Washington	74,195	19,258	....	....	65,000
Watertown	48,260	20,200	....	....	....
Mississippi:					
Forrest	....	....	....	....	500,000
Franklin	85,000	22,500	22,500	....	....
Grenada	100,000	5,000	100,000	....	175
Loundes	150,000	13,000	....	....	60,000
Quitman	130,000	None	None	None	140,000
Rice	299,659	....	....	....	22,000
Stevens	24,323	20,000	None	None	45,000
Winston	32,000	None	None	....	....
Missouri:					
Holt	55,000	85,000	....	500	95,000
Oregon	5,000	150,000	30,000	....	150,000
Pulaski	10,000	25,000	....	....	30,000
Saint Clair	50,000	12,000	....	....	175,000
Schuyler	59,424	6,000	None	None	110,000
Shannon	13,500	None	None	....	None
Montana:					
Beaverhead	49,996	13,049	None	None	65,000
Gallatin	118,000	....	83,860g	....	130,000
Missoula	46,802	11,500	38,700	116,000h	85,000
Pondera	23,000	None	None	None	30,000
Sheridan	45,500	None	None	None	40,000
Toole	20,000	15,000	....	....	....
Nebraska:					
Deuel	3,000	None	None	None	....
Fillmore	51,000	21,000	15,000	....	75,000
Nance	....	21,000a	....	....	....
Otoe	30,000	16,000	14,000	....	128,000
Valley	....	20,000	20,000	....	....
Nevada:					
Elko	157,841	....	120,400	....	90,000
Lander	16,400	11,110	....	5,000	....
New Mexico:					
Sierra	4,000	5,000	3,000	....	113,000
New York:					
Madison	200,000	....	....	75,000	....
Tompkins	....	....	....	....	760,000
North Carolina:					
Chatham	75,000	None	None	....	70,000
Columbus	100,000	....	....	....	....
Durham	100,000	....	....	....	110,000
Tredell	660,000	175,000	None	None	990,000
Yadkin	18,000	25,000	None	None	45,000
North Dakota:					
Burleigh	35,000	None	None	None	180,000
Dunn	30,000	....	....	....	100,000
McLean	41,497	....	....	....	76,000
Mountrail	45,000	....	21,000	14,000	60,000
Pembina	17,000	None	None	....	90,000
Pierce	12,500	....	5,500	....	50,000
Slope	7,000	5,200	....	1,300	9,000
Stutsman	....	....	....	....	140,000
Walsh	16,000	16,000	32,000	....	None
Wells	20,000	....	10,000	....	....
Ohio:					
Auglaize	31,000	31,000	....	....	37,000
Brown	....	....	250,000	100,000	300,000
Clark	None	81,000	81,000	87,000	Not determined
Clinton	150,000	27,000	10,000	....	300,000
Fayette	....	....	....	....	115,000
Hardin	89,561	....	None	None	101,885
Harrison	200,000	75,000	10,000	....	150,000
Jackson	48,000	70,000	70,000	15,000c	....
Jefferson	243,000	100,000	50,000	None	357,000d
Madison	100,000	30,000	30,000	40,000	150,000
Marion	251,000	201,839	....	....	About 200,000
Medina	....	123,692	80,900	....	....
Preble	63,078	63,078	....	....	....
Sandusky	250,000	50,000	50,000	25,000	300,000
Union	....	....	....	....	284,000
Van Wert	90,000	45,500	24,000	38,000	....
Oklahoma:					
Comanche	115,000	....	....	....	500,000
Grady	100,000	....	....	....	....
Okmulgee	400,000	None	None	None	1,200,000
Oregon:					
Clatsop	50,000	1,500,000	....	....	1,039,950
Deschutes	61,000	40,000	10,000	....	300,000
Douglas	246,000	....	85,000	....	260,000
Marion	500,000	....	....	....	350,000
Yamhill	75,000	35,000	....	....	100,000

a—Includes Federal aid. b—By town. c—By township. d—By county. e—Also $17,920 from county and $43,400 from State for bridges. f—Future taxes. g—$65,000 of this for Forest Service. h—Forest Service. *Roads. †Bridges.

Roads Graded Only

County	Constructed during 1924: Miles	Constructed during 1924: Cost	Total in County at end of 1924	Average width of improved surface
Alabama:				
Coosa	5	10,000	21	24
Arizona:				
Greenlee	..	....	98	..
Maricopa	100	20,000b	1,500	20
Arkansas:				
Ashley	..	....	1,200	..
Desha	..	....	210	35
Polk	..	....	200	..
California:				
Butte	..	....	217.2	..
Fresno	..	....	4,000	..
Kings	24	3,700	1,580	24
Napa	4	24,000	..	24
Sutter	10	10,000c	185	30
Colorado:				
Gunnison	16	....	460	20
Rio Grande	70	19.076d	400	24
Florida:				
Bradford	140	180,000l	140	24
Jackson	..	....	800	..
Madison	..	....	..	..
St. Johns	68	8,500	420	66 rt. of way
Saint Lucie	18	16,000b	232	24
Santa Rosa	..	....	100	..
Georgia:				
Bacon	50	1,500	300	18
Clarke	..	....	50	..
Evans	10	....	..	..
Lee	..	....	..	..
Monroe	5	30,000b	41	26
Union	30	....	30	12
Upson	..	....	..	..
Idaho:				
Boise	10	201,000	184	20
Canyon	10	8,000b	..	..
Illinois:				
Menard	200	30 per mile	..	24
Sangamon	40	....	..	28
Indiana:				
Boone	..	....	139	..
Newton	..	....	234	..
Iowa:				
Appanoose	..	50,000	..	..
Buena Vista	20.5	40,000	195	..
Cass	10	....	30	28
Cerro Gordo	..	....	13.5	..
Chickasaw	4.5	1,900b	28½	26
Clayton	18	15,000b	..	26
Crawford	10	50,000	150	28
Dallas	45	36,100d	700	22
Decatur	5.647	28,884	28.817	..
Fayette	2.8	11,000	23.5	26
Grundy	..	....	10	..
Guthrie	..	....	30	24
Hamilton	9	25,000	20	26
Harrison	8.83	200,000k	32	30
Howard	7.5	28,000	..	28
Jasper	2.5	35,000	13.5	..
Johnson	1.163	6,096	69.6	28
Jones	8	30,000	42	28
Kossuth	31	60,000	260	..
Lyon	20.5	....	25.5	26
Mills	..	....	13.1	..
Muscatine	0.72	4,511	86.5	26
O'Brien	17	25,000b	..	28
Palo Alto	8.5	11,612	150	..
Plymouth	41	400,000b	120	..
Scott	13.6	70,897b	45	28
Van Buren	50	——	32	..
Winneshiek	3.5	10,000	50	..
Kansas:				
Bourbon	..	....	104	24
Butler	58.25	....	295.25	..
Chase	80	....	141	28
Comanche	42	....	280	..
Crawford	..	....	125	..
Ellis	80	....	124	..
Ellsworth	173	18,703	173	..
Finney	35	....	..	..
Kingman	10	57,000b	210	30
Meade	..	....	575	24
Morton	30	3,000	150	16
Pratt	..	....	..	..
Reno	15	400 per mile	275	28
Republic	..	....	211	28
Sheridan	500	20,000	..	..
Smith	..	....	1,740	28 Co. 24 twp.
Kentucky:				
Boyle	1	50	5	..
Garrard	..	....	150	14
Grayson	400	5,000	..	..
Marshall	400	2,500	..	..
Perry	9	250,000	9	..
Rockcastle	4	40,000b	15	..
Rowan	5	6,000	..	..
Webster	500	45,000b	520	18
Louisiana:				
Vernon	7	....	..	..
Maryland:				
Garrett	6	....	..	..
Michigan:				
Genessee	7.020	28,149b	..	..
Hillsdale	7	33,000	7	..
Keweenaw	1	5,280	4	..
Livingston	2	500	..	..
Luce	4	48,000c	13	..
Minnesota:				
Aitkin	12	50.682	169	..
Beltrami	4	6,000	1,600	20
Blue Earth	30.24	....	29.20	24
Brown	12.4	35,000d	22.5	24
Cook	17.34	69.420	134	18
Cottonwood	13.5	41,026b	5.5	24
Dakota	33	180,962	15	30
Dodge	15.25	81,596b	..	..
Goodhue	5.5	52,556	..	..
Grant	14	....	..	24
Houston	3.1	24,000b	9.63	24
Hubbard	..	....	4.00	24
Jackson	30	140,000	30	30
Lac Qui Parle	..	....	5.0	24
Le Sueur	40	166,000b	..	24
Lincoln	13.31	28,648b	119	24
Mahnomen	3	18,000	68	24
Marshall	13	17,000	52	..
Martin	32.0	....	32.8	..
Murray	28.5	53,797	37.7	24
Norman	9	15,000	..	..
Otter Tail	30	146,000	49	24
Pennington	11.5	....	..	26
Pipestone	14.0	51,000c	..	24
Red Lake	3.5	11,316	43.2	24
Redwood	120	....	..	..
Rice	6.94	32,769	13.50	24
Rock	..	....	12.0	24
Sibley	46.0	57,434	..	..
Stearns	35	....	..	24
Stevens	9.38	29,756	117.61	..
Swift	27	68,000	..	24
Washington	2.25	16,135	..	..
Watonwan	13	20,066b	15	24
Mississippi:				
Grenada	..	....	6	24
Harrison	30	....	654	24
Loundes	4	400	..	..
Quitman	15	....	150	25-30
Missouri:				
Holt	6	36,000e	25	24
Oregon	7	....	..	..
Pulaski	25	7,500	500	20
Schuyler	5	40,000f	..	..
Montana:				
Beaverhead	50	15,000	350	20
Chouteau	20	8,000g	2,771	28
Gallatin	25.0	12,700b	984.72	..
Missoula	..	....	371	..
Pondera	20	6,000	200	..
Sheridan	60	6,000	300	28
Toole	50	4,000	..	..
Nebraska:				
Deuel	44	300	200	24
Fillmore	100	25,000h	500	..
Otoe	125	....	175	22
Valley	10	40,000	34	24
Nevada:				
Elko	65	7,000	350	20
North Carolina:				
Chatham	30	40,000b	400	22-26
Durham	10	20,000	..	..
McDowell	8	....	..	..
Yadkin	30	3,000b	200	18
North Dakota:				
Burleigh	5	4,850	1,890	24
Dunn	10	2,500	250	..
McLean	15	665	1,053	18
Morton	20	....	..	20
Mountrail	10	900	..	..
Pembina	..	....	2,000	..
Pierce	50	....	750	20
Slope	52	180c	..	..
Stutsman	23	30,000	339	24
Wells	145	....	..	24
Ohio:				
Auglaize	..	....	22	..
Brown	8	100,000i	..	18
Clinton	..	40,000b	..	..
Defiance	2.5	5,000b	..	..
Harrison	5	25,000j	..	..
Sandusky	..	....	300	..
Union	..	....	85	20
Warren	..	....	101.7	..
Oklahoma:				
Comanche	200	(a)	..	..
Grady	200	40,000j	234	..
Oregon:				
Deschutes	13	51,000	13	24
Douglas	4.8	....	..	..
Yamhill	10	....	..	16

A—By force account. b—Includes bridges. c—Includes culverts. d—Includes bridges and culverts. e—Includes 2 bridges. f—Includes 9 steel bridges. g—Includes 5 bridges. h—Includes 12 bridges, $15,000. i—Includes 10 small bridges. j—Includes 10 bridges. k—Includes 7 bridges. l—Includes 85 bridges.

Gravel Roads

County	Constructed during 1924 Miles	Cost	Total in County at end of 1924	Average width of improved surface
Alabama:				
Coosa	..	....	23	24
Morgan	10	$20,000c	..	..
Arizona:				
Greenlee	1	3,647	64	18
Maricopa	6	9,000b	8	18
Arkansas:				
Ashley	..	....	300	..
Clay	10	....	..	..
Desha	30	....	..	..
Polk	..	....	58	..
California:				
Butte	..	....	601.75	..
Fresno	19a	88,800b	66.82	16
Kings	2	....	..	..
Napa	2	3,000	..	18
San Joaquin	13.6	68,000	90.74	12
Sutter	25	75,000c	220	10-20
Colorado:				
Gunnison	9	....	15	22
Rio Grande	4.23	25,000d	39.23	26
Florida:				
Santa Rosa	..	....	2.0	..
Georgia:				
Evans	15	....	..	..
Lee	1	16,500	..	..
Idaho:				
Canyon	(e)	....	..	..
Illinois:				
McHenry	..	792	..	..
Whiteside	3	3,000	89	15
Indiana:				
Bartholomew	325	....	..	..
Boone	3	15,000b	6.88	9
Clinton	7.25	37,165	917.9	24
De Kalb	20	60,000	150	14
Howard	21.57	....	..	..
Jackson	6	34,424h	565	14-20
Knox	25	200,000b	515.51	16
Iowa:				
Buena Vista	..	....	175	24
Cerro Gordo	26	48,000	65	20
Chickasaw (f)	15	9,400	39½	26
Clayton	6	2,000b	..	..
Crawford	10	20,000	14	20
Dallas	49.5	175,600d	251	24
Emmet	25	100,000	140	26
Fayette	12.1	....	110	26
Grundy	..	....	9	..
Hamilton	6	6,000	150	..
Howard	..	....	40	..
Jasper	..	....	55	28
Jones	10	20,000	..	..
Kossuth	80	90,000	225	26
Lyon	16	20,000	81.5	28
Muscatine	1	1,249	12.3	..
O'Brien	8.5	15,000b	..	..
Palo Alto	14.75	12,900	93	24
Sac	..	....	150	..
Scott	1.5	9,963b	35	18
Van Buren	12	30,000b	12	24
Kansas:				
Butler	6.26	48,547	6.26	18
Ellis	0.25	....	0.25	..
Osborne	9	80,000b	..	18
Kentucky:				
Boyle	..	....	85	12
Garrard	..	....	10	14
Marshall	35	....	..	..
Rockcastle	10	40,000i	17	12
Rowan	9	....	..	..
Webster	19	240,000b	..	..
Louisiana:				
Acadia	50	250,000j	250	12
East Feliciana	15	....	..	..
Vermilion	80	500,000b	119	14-9
Michigan:				
Alger	13	90,000	130	16
Chippewa	20	....	60	16
Genesee	36.5	303,566k	471	15
Hillside	16	110,000	229.5	12
Jackson	2.5	17,000	..	..
Lake	3.5	24,000	75	12
Livingston	16	112,000i	75	16
Luce	..	....	19	16
Shiawassee	6	40,000d	280	9
Minnesota:				
Aitkin	3	3,451	..	..
Beltrami	2	1,800	75	20
Blue Earth	16	....	139.65	24
Brown	7.9	8,000d	143.5	..
Cass	..	....	18	..
Cook	7.60	7,745	..	..
Cottonwood	6.5	9.247b	64	18
Dakota	41	31,500c	183	30
Dodge	0.3	1,135	..	..
Goodhue	25.0	91,402	160.9	20
Grant	17	....	..	..
Houston	3	....	4.73	..
Hubbard	..	....	17.51	..
Jackson	12	25,000	125	25
Lac Qui Parle	46	40,939	137.3	..
Le Sueur	50.25	75,000b	..	..
Lincoln	15.5	9,120b	59	..
Marshall	50	90,000	125	..
Martin	24.03	....	109.1	24
Murray	27.0	39,317	97.6	24
Norman	9	18,750	..	..
Otter Tail	11	13,900	99	..
Pennington	4	....	70.75	26
Pipestone	..	....	75.5	..
Red Lake	..	....	22.3	24
Redwood	45	35,000b	..	..
Rice	72.42	132,313	258.66	24
Rock	15.0	25,662	92.0	24
Sibley	32.8	29,107	..	18
Stearns	22	19,000	..	..
Swift	21	33,200	120	22
Washington	3.50	9,332	54.20	24
Watonwan	25	32,058l	106.0	24
Mississippi:				
Franklin	..	....	96	..
Grenada	16	200,000l	52	16
Harrison	10	800	48	18
Loundes	..	....	..	..
Quitman	15	70,000	100	14
Missouri:				
Miller	30	1,700	..	30
Oregon	7	....	..	..
Pulaski	6	1,800	6	12
Montana:				
Beaverhead	10	25,000	30	24
Gallatin	25.5	81,350b	93.2	18
Missoula	7.8	164,482m	22.3	18
Toole	..	....	33	16
Nebraska:				
Deuel	20	....	..	..
Nevada:				
Elko Co.	23	33,000	100	9
Lander	16	26,200	..	18
North Carolina:				
McDowell	20	....	..	..
North Dakota:				
Burleigh	..	....	27	24
McLean	5	3,200	5	24
Pierce	10	....	50-60	..
Stutsman	8	30,000	14	24
Wells	20	1,100	..	..
Ohio:				
Auglaize	10	....	225	10
Brown	40g	....	..	..
Clark	..	....	..	14
Clinton	2	6,156b	..	..
Defiance	2.0	6,000b	300	12
Hardin	..	....	155.2	..
Madison	6	36,000n	512	12
Marion	..	....	106	..
Preble	..	....	773	16
Union	..	....	347.8	15
Van Wert	..	....	17.5	10
Warren	..	....	457.0	16
Oklahoma:				
Comanche	..	....	100	..
Okmulgee	..	....	20	18
Oregon:				
Clatsop	..	12,000p	134	24
Deschutes	..	....	92p	18
Douglas	29.0	....	602.5	10
Marion	40	120,000	..	18
Yamhill	5	....	1,250	16

A—Oiled. b—Includes bridges. c—Includes culverts. d—Includes bridges and culverts. e—About 60 per cent. of the roads are gravelled and charged to upkeep. f—By county only. g—By state. h—Includes 20 small bridges. i—Includes bridges under 30 feet span. j—Includes 15 small bridges. k—Includes bridges under 16 feet span. l—Includes 17 bridges. m—Includes one bridge costing $33,000. n—Includes 3 bridges. p—Includes water-bound macadam.

Grading included in costs in all cases except De Kalb, Ind.; Cerro Gordo, Chickasaw, Lyon, Muscatine and Palo Alto, Ia.; Boyle and Garrard, Ky.; Goodhue, Murray, Rock, Swift and Washington, Minn.; and Deschutes and Marion, Ore.

Water-Bound Macadam

County	Constructed during '24 Miles	Cost	Total in County at end of 1924	Average width of improved surface
Alabama:				
Morgan	40	200,000c	..	..
California				
Butte	3.0	....	3,0	18
Napa	2	14,000	..	18
San Joaquin	20.0	120,000	34.14	14
Florida:				
St. Lucie	4	52,000b	91	16-19
Georgia :				
Union	20	....	..	..

Water-Bound Macadam (Continued)

County	Constructed during 1924 Miles	Cost	Total in county at end of 1924	Average width of improved surface
Indiana:				
Du Bois	23.3	227,020b	162.6	9
Knox	..	....	57.43	16
Monroe	20	150,000e	300	12
Newton	2.5	21,000	400	9
Iowa:				
Johnson	1.01	5,765	1.71	..
Kansas:				
Bourbon	..	....	9.5	14
Kentucky:				
Boyle	5.75	20,000	110	16
Garrard	9	75,000	180	16
Grayson	0.5	2,600	..	..
Rockcastle	5.5	44,000f	22	14
Woodford	14a	83,000g	224	16
Maryland:				
Garrett	..	....	54	16
Michigan:				
Chippewa	2	20,000	11	16
Keweenaw	..	....	19	16
Luce	4	60,000c	16	16
Minnesota:				
Houston	0.5	504b	1.7	..
Montana:				
Gallatin	..	....	7.0	18
Ohio:				
Brown	12	....	..	16
Defiance	12.0	93,000b	26	12
Fayette	..	42,000	7	..
Hardin	1.01	9,642b	17.0	18
Harrison	2	26,000b	52.6	12
Jefferson	15.63	247,223	174.28	10
Madison	..	....	16.2	..
Marion	20	171,000b	35	12
Preble	..	....	27	..
Sandusky	5.0	55,000b	570	16
Union	7	108,000h	..	18
Van Wert	..	....	18.2	..
Warren	..	....	12.2	..
Oklahoma:				
Rogers	..	....	6	28
Oregon:				
Yamhill	10	....	1,000	16

a—Reconstructed. b—Includes bridges. c—Includes culverts. e—Includes 20 bridges under 20 feet. f—Includes bridges under 30 feet span. g—Includes 3 small bridges. h—Includes bridges less than 20 feet. Grading included in costs in all cases except Boyle and Garrard, Ky.

Road Realignment Saves Money

The commissioners of Wyandotte County, Kansas, have reported that by an investment of $5,000 for a right-of-way to enable it to straighten out a crook in a county road it has been able to so shorten the total length of road that the cost of paving it with concrete was reduced by $20,000, thus giving a net saving of $15,000 besides greatly improving the road as a traffic route.

Sand-Clay Roads

County	Constructed during 1924 Miles	Cost	Total in County at end of 1924	Average width of improved surface
Alabama:				
Coosa	3	$10,500	..	24
Arizona:				
Maricopa	7	10,000b	10	20
Arkansas:				
Ashley	..	....	300	..
Florida:				
Jackson	15	....	200	24
Madison	169	....	175	30
Saint Lucie	..	....	71	12
Santa Rosa	16.5	30,000b	40	..
Georgia:				
Evans	10	....	..	..
Lee	5	....	24	26
Iowa:				
Muscatine	..	....	6.2	..
Kansas:				
Ellsworth	1.5	3,264	..	18
Finney	..	....	5	26-28
Pratt	15	300 per mile	45	26
Morton	3	2,000	..	18
Michigan:				
Keweenaw	..	....	24.7	..
Minnesota:				
Cass	..	....	132.9	..
Houston	..	....	3	..
Hubbard	..	....	46.73	..
Otter Tail	..	....	48	..
Red Lake	..	....	1.5	..
North Carolina:				
Columbus	22	40,000	..	26
Yadkin	..	60	..	..

b—Includes bridges. Grading included in costs in all cases except Muscatine, Ia.

Top Soil Roads

County	Constructed during 1924 Miles	Cost	Total in county at end of 1924	Avrage width of improved surface
Alabama:				
Coosa	..	....	97	24
Georgia:				
Clarke	..	....	70	..
Evans	60	....	..	..
Upson	8	....	20	26
Wilkes	34.68	209,800a	..	28
Kansas:				
Reno	4	2,000 per mile	30	24
Michigan:				
Luce	..	....	7	..
Minnesota:				
Stearns	25	56,000	..	..
North Carolina:				
Columbus	20	20,000	..	..
Durham	10	....	..	..
McDowell	2	....	..	..
Yadkin	10	4,000b	..	..
Ohio:				
Preble	..	....	43	..

a—Includes 5 bridges. b—Includes bridges. Grading included in costs in all cases.

Bituminous Macadam and Bituminous Concrete

County	Bituminous Macadam: Constructed during 1924 Miles	Cost	Total in County at end of 1924	Average width of improved surface	Bituminous Concrete: Constructed during 1924 Miles	Cost	Total in County at end of 1924	Average width of improved surface
Arizona:								
Maricopa	5	$140,000b	20	16-18	....	....	....	....
California								
Butte	54.7	....	127.5	15	....	....	35.75	15
Fresno	..	....	..	..	32.84	$579,000	189.50	16
Napa	2	14,000	..	18	None	....	....	....
San Joaquin	9.27	82,000	378.07	16	....	....	....	....
Sutter	..	....	45.63	15	11.83	245,000c	11.83	....
Florida:								
St. Johns	13	123,000	38	12	....	....	....	....
St. Lucie	8	282,000b	10	16	....	....	....	....
Georgia:								
Clarke	..	125,000	6	24	....	....	....	....
Indiana:								
Bartholomew	100	....	..	..	....	....	....	....
Monroe	3	....	6	..	....	....	....	....
Newton	..	....	1	40	....	....	....	....
Kansas:								
Bourbon	..	....	40	16	....	....	....	....
Crawford	..	....	4	16	....	....	....	....

Bituminous Macadam and Bituminous Concrete (Continued)

County	Constructed during 1924 Miles	Constructed during 1924 Cost	Total in County at end of 1924	Average width of improved surface	Constructed during 1924 Miles	Constructed during 1924 Cost	Total in County at end of 1924	Average width of improved surface
Michigan:								
Keweenaw	0.6	7,300	1.4	..	....	....	....	....
Mississippi:								
Harrison	..	....	..	..	5	....	26	20
New York:								
Madison	12	96,000	120	10	....	....	....	....
Tompkins	15	162,000	84	10	....	....	....	....
North Carolina:								
Tredell	10	175,000	10	18	14	540,000	14	18
Ohio:								
Auglaize	3	....	16	18	....	....	....	....
Brown	1	....	..	16	....	....	....	....
Defiance	30	69,000b	82	16	....	....	....	....
Fayette	..	....	93	..	....	....	....	....
Hardin	3	78,999b	383.2	18	....	....	4.4	....
Harrison	8	40,500b	36.0	16	....	....	....	....
Jefferson	25.3	282,990	103.10	16	....	....	....	....
Madison	..	....	40.5	18	....	....	....	....
Marion	7.75	201,839b	60	18	....	....	2	....
Sandusky	5.5	165,000b	5.5	18	....	....	....	....
Union	..	....	95.96	16	....	....	....	....
Van Wert	5.60	118,000b	17.3	16	....	....	....	....
Warren	..	....	8.0	16	....	....	....	....
Oklahoma:								
Okmulgee	..	....	5	18	....	....	....	....
Rogers	..	....	6	28	....	....	....	....
Oregon:								
Clatsop	..	....	..	..	2	30,000	16	16
Douglas	..	....	..	..	....	....	0.5	16
Marion	..	....	..	..	22	220,000	122	16
Yamhill	..	....	..	..	....	....	....	16

b—Includes bridges. c—Includes culverts. Excavation included in all costs except Marion, Ore.

Brick and Other Kinds

County	Brick: Constructed during 1924 Miles	Brick: Constructed during 1924 Cost	Brick: Total in County at end of 1924	Brick: Average width of improved Surface	Other Kinds: Kind	Other Kinds: Constructed during 1924 Miles	Other Kinds: Constructed during 1924 Cost	Other Kinds: Total in County at end of 1924
Florida:								
Bradford	..	....	..	..	Rock base, surface treated	22	$500,000	22
Madison	..	....	..	..	Rock asphalt	11	....	..
St. Johns	..	....	53	9	.....	..	....	..
Santa Rosa	..	....	6	9	.....	..	....	..
Indiana:								
Boone	..	....	5	18	.....	..	....	..
Clinton	..	....	8	..	.....	..	....	..
Knox	..	....	10.0	..	.....	..	....	..
Iowa:								
Scott	..	....	23.5	18	.....	..	....	..
Kansas:								
Bourbon	4	$149,632	4.5	18	W. B. surf. treated	2	3,000	40
Butler	10.25	143,061	..	18	.....	..	....	..
Crawford	..	....	4.5	18	Chats	..	....	48
Reno	..	....	53	18	.....	..	....	..
Mississippi:								
Grenada	..	....	..	..	Sheet asphalt on 6-in. concrete	2	70,000b	2.0
Ohio:								
Auglaize	..	....	9.5	18	.....	..	....	..
Hardin	..	....	1	..	K'y rock asphalt	..	....	17.3
Harrison	..	....	1.4	..	Cinders	..	....	16
					Sandstone pike	2	11,500	..
Jackson	..	....	0.2	16	.....	..	....	..
Jefferson	3.30	268,661	22.91	18	.....	..	....	..
Madison	..	....	3	..	.....	..	....	..
Marion	..	....	6	..	.....	..	....	..
					Sheet asphalt, Traffic-bound mac.	..	....	2
Preble	1.045	43,099	11.945	17	K'y rock asphalt	..	....	342
						..	....	1.1
Sandusky	..	....	60	18	.....	..	....	..
Union	..	....	..	..	Traffic-bound mac.	..	....	293
Van Wert	..	....	..	..	K'y rock asphalt	..	....	5.8
					Stone	..	....	706
Oklahoma:								
Okmulgee	..	....	..	..	Topeka top	..	....	12
					Shale	..	....	15
Oregon:								
Clatsop	..	....	..	..	Planked	3	3,000	11

b—Includes bridges. Grading included in all costs.

Cement Concrete

County	Reinforced Concrete: Constructed during 1924 Miles	Reinforced Concrete: Constructed during 1924 Cost	Reinforced Concrete: Total in County at end of 1924	Reinforced Concrete: Average width of improved surface	Concrete not Reinforced: Constructed during 1924 Miles	Concrete not Reinforced: Constructed during 1924 Cost	Concrete not Reinforced: Total in County at end of 1924	Concrete not Reinforced: Average width of improved surface
Arizona:								
Maricopa	..	....	..	..	14	$550,000	360	16 to 20
Arkansas:								
Desha	..	....	..	..	..	....	40a	..
California:								
Fresno	..	....	..	..	..	....	29.78a	16
Kings	..	....	23	..	..	....	..	..
Napa	..	....	3	..	..	....	52	18
Sutter	..	....	5	..	10.74	230,000c	22.81	..
Florida:								
Escambia	6.50	$220,728	..	..	8.25	261,852	40.5	18
St. Lucie	..	....	..	..	7	260,000b	7	18
Santa Rosa	2.0	46,000b	..	9 and 18	..	....	..	..
Georgia:								
Clarke	..	55,000	2	18	..	250,000	10	18
Monroe	..	....	..	..	3.5	....	..	..
Illinois:								
McHenry	..	....	..	..	36	....	54	18
Scott	13	39,000	20	18	..	....	..	..
Indiana:								
Bartholomew	25	....	..	..	..	....	..	..
Boone	12	300,000	20.0	18	..	....	4	18
Clinton	..	....	..	..	..	....	23.5	..
De Kalb	0.6	17,000	..	..	..	....	..	..
Jackson	10	....	10	..	..	....	None	..
Knox	5.5	99,000	..	18	..	....	17.	..
Monroe	..	....	..	..	2	....	5	..
Iowa:								
Cerro Gordo	..	....	37	18	..	....	2	16
Johnson	..	....	..	..	None	....	3.5	..
Kossuth	..	....	14.5	18	..	....	None	..
Muscatine	..	....	0.41	16	..	....	..	..
Palo Alto	..	....	11	..	..	....	..	..
Scott	..	....	33.1	18	..	....	None	..
Kansas:								
Bourbon	..	....	..	..	..	....	1	24e
Crawford	..	....	30	18	..	....	..	..
Finney	..	....	..	..	..	....	35	16
Reno	..	....	..	..	..	....	8	10
Kentucky:								
Webster	..	....	None	..	1	42,000b	..	..
Michigan:								
Genesee	1	35,482f	4	18	19	549,468f	65.25	18
Hillsdale	..	....	..	..	5	134,100	9	20
Jackson	10.25	360,000	..	..	..	....	..	..
Keweenaw	..	....	..	..	..	....	1.3	..
Livingston	..	....	..	..	18	720,000g	30	20
Shiawasseee	..	....	..	..	0.75	28,000d	22	20
Minnesota:								
Goodhue	0.25	5,356	..	..	..	....	..	..
Houston	..	....	0.68	..	..	....	..	..
Rice	..	....	0.87	18	..	....	..	..
Stearns	6	....	..	..	..	....	..	..
Swift	..	....	7.5	18	..	....	..	..
Mississippi:								
Harrison	..	....	10	20	..	....	..	..
Montana:								
Gallatin	..	....	..	..	..	....	3.79	18
Nebraska:								
Otoe	2	....	..	..	..	....	..	..
New York:								
Madison	..	....	..	..	4	45,000	10	10 and 16
North Carolina:								
Columbus	12	....	..	18	..	....	..	..
Yadkin	..	....	..	..	..	....	7	18
North Dakota:								
Burleigh	..	....	1.1	18	..	....	..	..
Morton	2.98	107,752	..	18	..	....	..	..
Ohio:								
Auglaize	2	....	14	18	..	....	15	18
Hardin	..	....	1.6	18	..	....	..	..
Clark	6	162,000h	..	..	..	....	..	..
Defiance	6.0	148,000b	58	16	2.0	44,000b	20	15
Harrison	..	....	2.6	8	..	....	2.9	..
Jackson	61	200,000	16	16	..	....	..	..
Jefferson	..	....	..	..	3.55	202,111	4.0	20
Madison	..	....	3	..	..	....	..	..
Medina	..	....	..	..	6.94	204,592j	..	16
Preble	..	....	..	..	2.73	83,058b	7.73	16
Sandusky	..	....	15	18	..	....	3	16
Union	..	....	5.94	16	..	....	..	..
Van Wert	0.52	11,803	6.70	16	..	....	..	..
Warren	..	....	..	..	..	....	0.6	..
Oklahoma:								
Okmulgee	..	....	..	..	..	....	18	..
Oregon:								
Clatsop	..	....	..	..	3	75,000b	25	16
Douglas	..	....	..	..	1.25	....	2.5	16

A—With bituminous top. b—Includes bridges. c—Includes culverts. d—Includes bridges and culverts. e—In village. f—Includes bridges under 16 feet span. g—Includes bridges up to 30 ft. span. h—Includes 4 bridges and 8 small culverts. i—State highway. j—Includes 2 bridges.

Grading is included in all the costs given above except in the cases of De Kalb, Ind.; Cerro Gordo, Muscatine, and Palo Alto, Ia.; Goodhue and Swift, Minn.; Otoe, Neb.

Maintenance of County Highways

County	Maintenance Cost in 1924: Kind of road	Amount spent	Miles maintained	Patrol Maintenance: Miles patrolled	Kinds of roads	Equipment of each patrolman	Gang Maintenance: Kinds of Road	No. of gangs	No. of men to a gang	Equipment of each gang
Alabama:										
Coosa	Graded	$3,000	21	..	....	.....	Sand-clay, gravel	2	12	Plow, wheeler, graders, tractor, scarifier, finisher, drags, shovels
	Top soil	5,000	97							
	Gravel	2,875	23							
Crenshaw	Unimproved	10,000	150	5	Dirt	Fordson, grader	Dirt	3	2, 2 & 1	Fordson, grader
Arizona:										
Greenlee	Unimproved	1,426	105	12	Gravel	Grader, fresno, drag, wagon	Various	3	4 to 8	Trucks, tractor, grader, drag, etc.
	Graded	12,148	98							
	Gravel	17,186	64							
Maricopa	Graded	75,000	1,500	180	Gravel	Truck, grader, drag	Dirt	3	15	Teams, scrapers, tractor, grader, truck, rooter plow
	Sand-clay	500	10							
	Gravel	400	8							
	Bit. macadam	500	15							
	Cem. concrete	12,000	346							
Arkansas:										
Ashley	Unimproved	20,000	1,200	30	Gravel	Truck, grader, scarifier, etc.	Gravel	1	5	Truck, grader, scarifier
California:										
Fresno	Oiled gravel	23,261	66.82	..	....	.....	All roads	1	..	Whatever necessary
	Bit. concrete	10,293	189.50							
	Conc., asp. surf.	1,071	29.78							
Kings	Graded	105,092	1,580	104	Bit. concrete	1-man grader, Best 30, Nash Quad.	Dirt	4	4 to 10	Carts, trucks, graders, drags, sand wagons, dump trucks
	Bit. con.	13,190	104							
San Joaquin	Gravel, mac. and bit. mac.	63,570	503	..	....	.....	.....	..	..	.....
Sutter	Gravel	3,000	8	All	Paved	1-ton truck, oil heater, small tools	.....	2	3	Truck, oil heater, small tools
	Bit. macadam	6,000	45.63							
	Concrete	1,000	27.81							
Colorado:										
Clear Creek	Unimproved	43,000	136	88	Unimproved	Horses, Trucks, grader	Unimproved	10	1 to 10	Horses, wagons, trucks, graders
Gunnison	Graded	34,000	400	220	Graded, gravel.	Truck or tractor, grader	Improved	12	2 to 12	Tractors, plows, fresnos, teams
Rio Grande	Graded	12,500	400	94	Graded, gravel	Small grad., drags, Avery maintainer	Gravel	4	1 to 4	.....
	Gravel	14,677	94							
Florida										
Bradford	Graded	....	140	..	....	.....	Graded	4	3	Dump truck, 3-way drg, tractor
Escambia	Concrete	79,245	40.5	..	....	.....	All	4	12	Grader, wagons & mules, hand tools
Jackson	Graded	....	800	..	....	.....	Graded & sand-clay	5	5	8 mules, grader, road plow, rooter, 3 drag scrapers, 2 wagons, hand tools
	Sand-clay	....	200							
St. Johns	Brick	75,000a	53	75	Brk., asph., mac.	Truck & 4 men	Unimproved & graded	8	4 convicts	Hand grading, clearing R. of W.
Saint Lucie	Graded	24,000	232	93	Macadam	Truck, patch kettle, shovels, etc.	Graded & sand-clay	4	3 or more	Truck, tractor, drag, grader, various tools
	Sand-clay	32,000	71							
	W B macadam	39,000	91							
	Bit. macadam	2,000	2							
Santa Rosa	Graded	36,000	100	..	....	.....	Sand-clay	5	5 aver	Tractor, grader, plow, shovels, slip scrapers, truck, wagons & mules
	Sand-clay		40							
	Gravel		2							
	Concrete		2							
	Brick		6							
Georgia:										
Bacon	Graded	3,000	300	..	....	.....	.....	..	..	.....
Clarke	Top-soil	15,000	70	..	....	.....	All	2	20	Road machines, tractors, mules, scarifiers, etc.
	Cement conc.	1,400	12							
Evans	....	....	..	24	Gravel	Tractor on truck, grader	.....	1	5 to 7	Tractor, truck, grader
Lee	....	....	..	558	Sand-clay & unimproved	Ten-ton tractor, 5-ton, 4 road mach. 6 drags	.....	..	..	.....
Monroe	....	5,500	41	41	Dirt	Road drag, ditching mach., etc.	Soil	1	5	.....
Union	Graded	....	40	..	....	.....	Grading	3	3	Tractors, scrapers
Upson	Unimproved	36,000	730	..	....	.....		1	20 convicts	Two 10-ton tractors, 1-man tractor
	Top soil	(b)	16						7 gds., etc.	Fordson, 6 rd. mach. 18 mules
Wilkes	Unimproved	34,000	200	..	....	.....	Unimproved	3	4, 5 & 16	5-ton tractor, 10-ton tractor, 6-wheeler outfit

Idaho:										
Boise	Graded	22,500	184	17	Dirt	Wheeled grader, fresnos, slip grader, plows, teams	New roads	2	10 to 12	Teams, plows, scrapers, etc.
Illinois:										
McHenry	Gravel	....	792	175	Gravel	2-horse grader, slip grader	Gravel	2	2 & 4	Tractor & 10-ft. grader; gravel crushing outfit & truck
Menard	Graded	....	104	100	Dirt	Drag, wheel main.	.....	..	..	.....
Sangamon	Graded	15,000	150	150	Oiled	6 ft. blade grader, slip scraper	.....	..	..	.....
Scott	Unimproved	15,000	325	..	....	.....	Dirt	1	b	Tractor, grader, maintainer
Whiteside	Gravel	14,650	127.3	166	Gravel & dirt	6 ft. blade grader, scraper	.....	..	..	.....
Indiana:										
Bartholomew	Unimproved	90,000	450	300	Gravel	Drag, grader	.....	..	..	.....
Boone	Gravel	119,820	688	..	....	.....	Gravel	22	4	Drags, graders; hired teams & 3 county trucks haul material
Clinton	Gravel	113,000	840	815	Gravel	Grader, drag	Gravel	1	6	Trucks, graders, drags.
Dubois	W B macadam	20,000	162.6	162.6	Gravel & mac.	Truck, team scraper, etc.	Gravel & mac.	10	4 to 5	Trucks, teams, scrapers, etc.
Howard	Unimproved	196,578	576	..	....	.....	.....	..	..	.....
Jackson	Gravel	80,000	560	..	....	.....	Gravel & concrete	22	1 to 20	Graders, drags, shovels, picks, concrete mixer
Knox	Gravel	120,000	515.5	..	....	.....	Grav., mac. & conc.	25	..	Drag, grader, slips
	W B macadam	65,000	57.4	..	....					
	Concrete	5,800	17.0							
Monroe	W B macadam	73,000	150	..	....	.....	Macadam	1	3	Scarifier, grader, roller
Newton	W B macadam	63,000	400	400	Macadam	Furnish their own	.....			.....
Iowa:										
Buena Vista	Gravel	65,000	175	175	Gravel	Team & grader	All	3	2	Truck, maintainer; one tractor & grader
Cass	Graded	....	170	170	Dirt	Maintainer, four horses, scraper, wheeler	Dirt	3	2	Tractor & heavy blade grader; 7 teams & wheelers for 1 gang
Cedar	Unimproved	20,332	87.6	153	Dirt	Team, small drag, small grader	Dirt	3	2	Tractor, maintainer
	Graded	28,854	76.0							
Cerro Gordo	Unimproved	....	800	165	Gravel & dirt	Truck & 15 ft. maintainer, or team & 8 ft. blade	Concrete & bridges	4	6	Two trucks, tar kettle, small tools, concrete mixer, pump
	Graded	....	13.5							
	Gravel	19,500	65							
	Concrete, reinf.	5,100	34							
	Conc., not reinf.	320	2							
Chickasaw	Graded	5,000	76	154	All	Team & grader	Gravel	1	Varies	Varies
	Gravel	1,700	39							
Clayton	Unimproved	12,000	50	264	Dirt	Drag, patrol grad.	Earth	3	4	Tractor, 12 ft. blade, shovels, brush scythes
	Graded	12,000	53.4							
	Gravel	500	10							
Crawford	Unimproved	39,000	1,140	160	Earth	Drag, grader	Earth & gravel	6	5	Truck, small tools
	Graded	30,000	160							
Dallas	Unimproved	....	100	300	Mostly gravel	Truck or tractor & blade maint.; or team & patrol grader	Mostly earth	7	6	Teams, wheelers, slips, plows, grads.
	Graded	46,000	600							
	Gravel	95,000	251							
Decatur	Graded	60,484	177.6	177.6	Earth	12 ft. blade grad.; some 6 ft. horse graders	Earth	6	3	Caterpillar, graders, small tools
Dubuque	....	....	..	170	Grav, clay, pav.	Pat. grader, small tools	All	2	5 & 7	Slips, wheelers, fresnos, graders, etc
Emmet	Gravel	37,111	106	106	Gravel	Horse patrol grad	.....	..	..	.....
Fayette	Unimproved	13,000	50	208	Dirt & gravel	Pat. grad. drag, slip, pick, scythe, mower, shovel, brush hook	Gravel & dirt	3	8	Crushing & screening plant, 4 Ford trucks, two 12 ft. blade graders, 6 wheels scrapers, 2 plows
	Graded	13,000	23.5							
	Gravel	26,000	110							
Grundy	Unimproved	14,000	180	100	Gravel & earth	Some, team & grader; others, truck & maint.	.....	..	..	.....
Guthrie	Unimproved	47,400	158	188	Earth	Horse & grader	Earth	1	6	Wheelers, slips, graders
	Graded	6,000	30							
Hamilton	Unimproved	3,000	30	150	Gravel	Truck or tractor, 15 ft. blade grader	.....	2	2	Large tractor, two 12-ft. graders
	Graded	500	4							
	Gravel	55,000	150							

Maintenance of County Highways—(Continued)

County	Maintenance Cost in 1924			Patrol Maintenance			Gang Maintenance			
	Kind of road	Amount spent	Miles maintained	Miles patrolled	Kinds of roads	Equipment of each patrolman	Kinds of Road	No. of gangs	No. of men to a gang	Equipment of each gang
Iowa (Continued)										
Harrison	Unimproved	6,000	..	94	Dirt	Drag	Dirt	2	4	Blade grader, 10-ton Holt, slip; other gang, Duplex maintainer and tractor
	Graded	4,000	32							
Howard	Graded	38,000	128	128	Earth & gravel	8 ft. patrol grad.	Earth & gravel	2	..	.....
Jasper	Unimproved	38,000	186	258	Dirt & gravel	One-man main.	Dirt	1	4	Truck, grader
	Graded	2,700	13.5							
	Gravel	20,000	55							
Johnson	Graded	66,727	186	111	Earth	Trac., 12 ft. grad., small tools	Earth	2	5 to 15	Tractors, graders, fresnos, wheelers, slips
Jones	Unimp. & graded	50,000	200	200	Earth & gravel	4-horse grad., slip plow, wheeler	Earth	3	2	Tractor, grader
Kossuth	Graded	15,000	260	250	Gravel	8 ft patrol grader, team, shovel	Earth	3	2	Truck, 10-ton Holt, 12-ft. grader, tar kettle, shovels, etc.
	Gravel	35,000	225							
	Concrete	350	14.5							
Lyon	Unimproved	6,500	62	81.5	Gravel	Team, 8 ft. grader	Gravel & dirt	1 part time	3	10-ton Holt, 12-ft. grader
	Graded	3,825	25.5							
	Gravel	24,000	81.5							
Mills	Graded	47,000	134	134	Earth	Grad., main., slip, plow	All roads	4	6 or 7	Tractor, slips, graders
Muscatine	Unimproved	58,179	65	151.5	Gravel	.....	23 var. of soil	7	2	Holt tractor, maintainer, 12-ft. grader, 8 ft. patrol grader, tools
	Graded		68							
	Sand-clay		6.2							
	Gravel		12.3							
O'Brien	Unimproved	30,000	80	196	Earth, gravel and paving	Truck, team, grader, plows, tools	Earth, Gravel & pav.	2	4	Blade, truck, concrete mixer, etc.
	Graded & grav.		116							
Palo Alto	Unimproved	15,630	123	123	Earth & gravel	Drag, team, wagon small blade, plow	Gravel	2	5	Trucks, blades, engines
	Concrete	,050	11							
Plymouth	Graded	75,000	240	230	Dirt	Grader, maintainer tractor, slip, etc.	Dirt	1	2	Grader, tractor
Sac	Gravel	99,096	150	150	Gravel	12-ft. maintainer, small tools	All	1	2	Tractor, graders, trucks
Scott	Unimproved	57,000	696	140	Concrete & dirt	.....	Dirt & gravel	5	3	Truck, small grader, large maintenance drag, small tools
	Graded	5,000	48.6							
	Gravel	10,000	35				Concrete	1	6	.....
	Concrete	18,000	33.1							
	Brick	17,000	23.5							
Tama	Unimproved	40,000	144	210	Gravel & dirt	Slip, grader, small tools; some light tractors	All	5	2	Tractor, 18-ft. blade
	Graded	20,000	40							
	Gravel	7,500	26							
Van Buren	Graded	20,000	50	130	Earth	2-horse grader & 12-ft. grader	Earth	2	4	10-ton Holt, 12-ft. Adams blade
Winneshick	Graded	40,000	280	115	Dirt	Grader, drag, etc.	.....	4	7	Wheelers, graders
Kansas:										
Bourbon	....	....	..	212	Paved & graded	Grader, plow, slip, drag, hand tools	.....	..	..	.....
Butler	Graded	113,941	295	295	Dirt	Grader, plow, slip, fresno, misc. tools	.....	..	..	.....
	Gravel	263	6.26							
	Brick	277	10.25							
Chase	Graded	4,073	141	...	.....	.....	Earth	2	4	10-ton Holt, 12-ft. grader, 2-ton dump truck
Crawford	Unimproved	20,187	500	125	Earth & chat	Drag, several have light graders	Concrete and brick	1	4	Truck with compressor and tar kettle, small tools
	Graded	18,230	100							
Ellis	Graded	12,000	124	124	Earth	Drag	.....	..	..	.....
Ellsworth	Graded	6,553	173	173	Dirt	10-ft. steel drag	Dirt	1	14	3 fresnos, plow team, 3 tractors
Finney	Unimproved	23,000	395	..	..	..	.....			
	Concrete	5,500	35				Concrete	1	5	Truck, tar kettle, small tools
Jackson	Unimproved	810	8.75	177	Earth	4-horse team or tractor, road planer, drag light grader	Earth	3	3	Holts, Adams graders, tandem wheelers
Kingman	Unimproved	15,000	210	210	Earth	10-ft. blade grader, fresno, plow harrow	.....	..	..	.....

Meade	Graded	38,945	575	500	Earth	Drags	.....	..	..	.....
Morton	Graded	2,000	90	...	.....	.....	.....	..	..	.....
Osborne	....	....	..	...	.....	.....	Gravel	1	..	Havelock mach., caterpillar tractor
Pratt	Graded	9,000	180	...	.....	.....	.....	..	..	Farmers drag 130 mi. at $1.75 per mi.
	Sand-clay	1,800	30							County maintains 36 mi. with 1 mai
Reno	Graded	55,000	275	366	Dirt & paved	8-ft. grader, slip, mower, shovel, ax, plow, wagon	.....	..	..	.....
	Top soil	6,000	30							
	Concrete	1,600	8							
	Brickc	9,100	53							
Republic	Graded	20,000	211	...	.....	.....	Earth	1	2	Tractor, 2 maintainers, grader
Sheridan	Graded	....	500	200	Earth	Drag	Earth	..	4 to 6	.....
Smith	Graded	15,000	752	752	Earth	Drag	Earth None at present	..		Fresnos, wheelers
Wabaunsee	Unimproved	8,000	195	...	.....	.....	County	3	2	Truck, grader, planer, small tools
Kentucky:										
Fleming	Unimp. & grad.	4,500	300	...	.....	.....	Macadam	..	30	.....
	W B macadam	27,500	300							
Garrard	Graded	1,500	150	..	....	.....	Macadam	3	30	.....
	W. B. Macadam	22,000	50							
Grayson	..	..	..	..	....	.....	Dirt	6	4	Graders, slip scrapers, tractors, teams, ditchers, plows
Marshall	Unimproved	1,000	150	150	Gravel	Fordson tractor, light grader	Gravel	2	4	Fordson, maintenance grader
Perry	Graded	..	5	5b	Gravel	.....	.....	..	..	.....
Rockcastle	Unimproved	3,000	30	18d	macadam & gr'l	.....	.....	2	6	.....
	Gravel	3,000	14							
	W. B. Macadam	11,000	14							
Rowan	Unimproved	2,000	150	18	Rock asphalt & gravel	.....	.....	1	..	Trucks, grader, etc.
Webster	Unimproved	..	20	19	Gravel	Tractor, grader drag	Gravel b	1	2	Tractor, grader, drag
	Graded	45,000	520							
Woodford	W. B. Macadam	20,000	80	42	W B macadam	Small truck, grader, tar heater, pouring kettle, tools, etc.	Surface-treated mac.	1	5 or 6	
Louisiana										
Acadia	Gravel	35,000	..	500	Gravel and dirt	Tractor, grader, drag, maintainer	Gravel and dirt	4	4	Tractors, graders, drags, maintainer
East Feliciana	Unimproved	(b)	15	..	....	.....	Dirt	..	..	Tractor, grader
Vermilion	Gravel	20,000	119	93	Gravel	Tractor, grader, truck	Gravel	5	varies	Tractor, grader, shovels, etc.
Vernon	Unimproved	(b)	..	..	....	.....	Graded	9	varies	Tractors, road machines, mules, planer, trucks
Michigan										
Alger	Gravel	45,000	130	130	Macadam and earth	Truck, drag	Macadam	3	4	Patrol grader, wagons, trucks
Chippewa	Sand clay	10,000	45	200	All	Adams patrols, truck, scrapers	Tar	5	5	Truck, mixer, small heater on wheels, small tools, shanty
	Gravel	30,000	118							
	W. B. Macadam	3,300	11							
	Bit. Macadam	18,200	26							
Genesee	Gravel	240,382	434.5	471	Gravel	Grader	Pavement	5	6	Trucks, mixer, tar kettle, etc.
	Concrete reinf.	91	3							
	Con. not reinf.	45,651	46.25							
	Detours & misc.	36,678	..							
Hillsdale	Unimproved	56,963	45	285.5	Gravel and unimproved	Horse patrol grader, or Fordson one-man grader, or truck with spring blade	Concrete (gravel as side issue)	2	5	Ford truck, small tools for shoulder and guard rail repair, brush clearing, tarring cracks, etc.
	G'l & detours		240.5							Tar kettle, etc.
	Concrete		5							
Jackson	....	..	..	340	Gravel	Motor	Pavements	2	3	
Keweenaw	Unimproved	2,250	12.0	30	Macadam	Tar kettle, shovels, picks, tamper scythe				
	Sand clay	5,500	24.7				Gravel and dirt	2	8	Truck, grader, roller
	W B macadam	17,550	19.0							
	Bit. macadam	200	0.8							
	Concrete	818	1.3							
Lake	Gravel	7,000	75	74	Gravel	Truck, small patrol grader	.....	1	2	Truck, hand tools
Livingston	Gravel	70,000	230	200	Gravel	Truck with scraper attachment or Fordson-grader combination	Concrete and gravel	2	5	Trucks, gravel screens, grading tools
	Concrete	3,600	12							

Maintenance of County Highways—(Continued)

County	Maintenance Cost in 1924			Patrol Maintenance			Gang Maintenance			
	Kind of road	Amount spent	Miles maintained	Miles patrolled	Kinds of roads	Equipment of each patrolman	Kinds of Road	No. of gangs	No. of men to a gang	Equipment of each gang
Michigan (Continued)										
Luce	Graded Top soil Sand clay Gravel W B macadam	2,873 2,538 1,547 11,488 11,512	.. ..	23	Gravel, macadam and earth	Patrol grader, small tools	Macadam, gravel	2	10 to 15	Trucks, small tools etc.
Shiawassee	..	..	..	..	Gravel	Light scraper and team	Gravel	1	12	.....
Minnesota										
Aitkin	Graded	25,519	169	..	....	.....	.....	..	..	.....
Beltrami	Gravel	12,000	161.5	141	Gravel	Grader, drag, mower, shovel				
Blue Earth	Graded Gravel	36,039	29 138	167	Gravel & earth	Grader, planer, fresno, small tools	.....	..	..	.....
Brown	Graded	35,000	137	137	Gravel and dirt	Patrol grader	Organized when needed		..	.....
Cass	Unimproved Sand-Clay Gravel	.. .. ..	19.5 132.9 18.0	170	Sand-clay and gravel	.....	.....	..	..	.....
Cook	Graded	8,391	66	64	Gravel	Truck or team with grader, or power grader	.....	..	..	.....
Cottonwood	Graded Gravel	5,000 5,000	55 64	119	Dirt and gravel	Team, grader, drag, small tools	Dirt and gravel	2	3 to 15	Tractor and blade, or gravel loader and trucks
Dakota	Unimproved Gravel	2,514 23,649	30 190	221	Gravel and dirt	6 ft. blade grader	.....	..	..	.....
Dodge	Unimproved Graded Gravel	1,059 2,118 7,411	19.0 15.25 56.35	50.1	Gravel	Patrol grader, wagon, mower, hand tools	.....	..	..	.....
Goodhue	Gravel	52,780	160.9	160.9	Gravel	Grader, drag planer	.....	..	..	.....
Grant	Graded	7,797	123	100	Gravel	Grader, wagon, fresno	.....	..	..	.....
Houston	Graded	28,000	109	109	Dirt	Patrol grader, drag, slip scraper	.....	..	..	.....
Hubbard	Graded	9,348	71.45	71	Sand-clay and gravel	Drag, patrol grader, slip scraper	.....	..	..	.....
Jackson	Graded	20,000	30	125	Gravel	Patrol grader, wagon, mower, scraper	.....	..	..	.....
	Gravel	..	125							
Lac Qui Parle	Unimproved Graded Gravel	26,000	0.35 5.0 137.3	142	Gravel	Team, wagon, blade grader, slip scrapers, shovels	.....	..	..	.....
Le Sueur	Unimproved Gravel	27,901	193.6 200	200	Gravel	Maint. grader, fresno, plow, mower to each 2 patrolmen	Unimproved	2	8	6 wheelers, plow, shovels, picks, etc. (Not employed all the time)
Lincoln	Graded	8,868	119	119	Gravel and dirt	8 ft. maintainer, grader, plow, fresno, wagon, gravel screen	Gravel	1	3	Wagons, fresnos, plow, screens
Mahnomen	Graded	5,500	68	68	Dirt	Patrol pony grader, 4-horse drag, slip or fresno	.....	..	..	.....
Marshall	Unimproved Graded Gravel	28,000	71 52 125	270	Earth & gravel	6 to 8 ft. graders				
Martin	Unimproved Graded Gravel	36,683	1.0 32.8 109.1	108	Gravel	Patrol grader, 2 horses, wagon, plow	.....	6	1	Drag and four horses

Murray	Graded Gravel	27,282	37.7 97.6	135	Earth & gravel	Small blade, wagon, mower, etc.	Where needed	1	2	Tractor, 12 ft. blade, elevator grader
Norman	Sand-clay	21,000	164	164	.....	6 ft. grader	.....	..	..	.....
Otter Tail	Unimproved Graded Sand-clay Gravel	70,000	148 49 48 99	354	Dirt, sand-clay gravel	Patrol grader, drag, planers	.....	3	6 to 12	Fresnos, wheelers, slips, 4-horse graders
Pennington	Unimproved Graded Gravel	12,176	38.25 7.00 70.75	70	Gravel	Grader, drag, planer, wagon, hand tools	Where needed, by contract	..		.....
Pipestone	Unimproved Graded Gravel	200 1,000 14,800	6 14 75.5	75.5	Gravel	Patrol grader with 8 ft. blade One 3-yd. truck hauls gravel	.....	..	..	.....
Red Lake	Unimproved Graded Sand-clay Gravel	18,869	22.3 43.2 1.5 22.3	104	All	Blade grader, plow, wagon, mower, drag, slip scraper, hand tools	.....	..	..	.....
Redwood	Unimproved	50,000	500	206	Gravel	8 ft. blade patrol grader	Regravelling	1	6	3 trucks
Rice	Unimproved Graded Gravel Concrete	75,608	247.0 13.5 258.7 0.9	520	Gravel & dirt	2-horse, 6-ft. patrol grader	.....	..	..	.....
Rock	Unimproved Graded Gravel	270 1,377 11,592	14 12 92	118	.....	Patrol grader, wagon, mower	.....	..	..	.....
Sibley	Gravel	25,842	134	134	Gravel	Patrol grad., plow, wagon, slip, hand tools	.....	..	..	.....
Stearns	Unimproved	28,000	210	222	Earth	Grader & team	.....	..	..	.....
Stevens	Graded Gravel	14,309 859	92.13 1.96	...	.....	.....	.....	..	..	.....
Swift	Gravel Graded	19,000	10 120	130	.....	6-ft. blade grader, small tools	.....	..	..	.....
Washington	Unimproved Gravel	18,027	52.95 54.20	107	Dirt	6-ft. blade grader, slip scraper, wagon & team, shovel, rake	.....	..	..	.....
Watonwan	Graded Gravel	1,154 15,183	15 106	106	Gravel	8-ft. patrol grader, fresno, wagon, mower	.....	..	..	.....
Mississippi:										
Franklin	Unimproved	6,000	40	20	Gravel	Wagon, slip, grader, shovels	Dirt	5	3	Graders, wagon, slips, shovels, etc.
Grenada	Unimproved Graded Gravel	8,000 600 5,000	266 6 35	60	Gravel	Patrol grad., team, slip, axe, pick, shovels	Unimproved	5	8 average	10-ton tractor, 4 trailers, road machines, plows, patrol machiue, Ford trucks
Harrison	Graded	90,000	654	...	.....	.....	All	7	8	Tractors, graders, drags, plows, wheel and slip scrapers
Loundes	Gravel	30,000	75	75	Gravel	Small grad., wagon, slip scraper, hand tools, 2 mules	.....	..	..	.....
Quitman	Graded Gravel	....	150 100	100	Gravel	Fordson tractor & grader, mules and grader	.....	..	..	.....
Winston	Unimproved	10,000	300	300	Sand-clay	Best tractor, Russell grader	.....	..	..	.....
Missouri:										
Holt	Graded	38,000	100	100	Earth	Team and drag	Earth	3	2	Maintainers, tractors, drags
Miller	Gravel	7,000	102	70	Gravel & earth	Drag, grad., roller	.....	..	..	.....
Oregon	Graded	16,000	70	70	Dirt	Rooter, grad., slip, shovels, pick	.....	..	..	.....
Pulaski	Graded	3,000	60	400	Earth	Team patrol, truck patrol, tractor patrol	State	3	4	Truck and team patrol
Saint Clair	....	....	..	70	Earth & gravel	Grader	.....	..	..	.....
Schuyler	Graded	....	40	40	Dirt	Grader, drags	Dirt	4	1	.....
Shannon	Unimproved	1,100	500	...	.....	.....	.....	..	..	.....

Maintenance of County Highways—(Continued)

County	Maintenance Cost in 1924: Kind of road	Amount spent	Miles maintained	Patrol Maintenance: Miles patrolled	Kinds of roads	Equipment of each patrolman	Gang Maintenance: Kinds of Road	No. of gangs	No. of men to a gang	Equipment of each gang
Montana:										
Beaverhead	Graded	10,000	250	250	Earth	Truck,3-way drags	Heavy repairs	3	5	3 teams, plows, scrapers, graders 3 trucks, drags, caterpillar with grader
Chouteau	Graded	1,000	200	200	Graded	2 sections of steel drag	48 districts	48	..	Plow, fresno, grader, slip scraper
Gallatin	Graded	25,000	984.7	...	.....	Small blade grader, drag, wagon, shovels	.....	..	..	.....
	Gravel		93.2							
	W B macadam		7.0							
	Bit. macadam		5.5							
	Concrete		3.8							
Missoula	Unimproved	2,000	1,375	1,200	.....	.....	All	3	9 average	Tractor, 2 trucks with trailer, grader, scarifier, small tools
	Gravel	52,781	22.3							
Pondera	Graded	2,000	200	...	.....	Drag. by farmers	.....	5	4	Plow, scrapers
Sheridan	Graded	3,000	300	300	.....	4-horse drag	.....	..	..	.....
Toole	Gravel	2,000	33	33	Gravel	Light grader	Graded	2	2 or 3	.....
Nebraska:										
Deuel	Graded	10,000	200	200	Dirt	Truck, maintainer	Dirt and gravel	4	2	Truck, maintainer
Fillmore	Graded	38,000	140	140	Earth	Grader, drag, wagon, plow, small tools	Earth	4	3 and 15	Blade on two gangs; Holt, blade and elevator or other two
Nance	Unimproved	22,923	92	92	.....	Grader, fresno, drag, shovels	.....	..	..	.....
Otoe	Unimproved	4,500	160	36	Gravel	.....	State	4	2	Tractors, trucks, maintainers, graders
	Graded	8,000	175							
Valley	Graded	12,000	34	..	Dirt	Maintainer, drags	Dirt	2	2 and 3	Drag, maintainer, tractor, truck grader, elevating grader.
Nevada:										
Elko	Graded	35,165	..	350e	Dirt and gravel	.....	.....	8	1 to 4	Fordson with grader attachment; or light grader and 2 horses, pick, shovel
	Gravel									
New Mexico:										
Sierra	Unimproved	13,000	100	..	.....	Trucks, graders fresnos, scrapers	.....	..	..	.....
New York:										
Madison	Unimproved	75,000	1,200	130	Macadam	Truck	Macadam and concrete	3	2	.....
	Bit. macadam	64,500	120							
Tompkins	Bit. macadam	41,000	140	140	Bituminous macadam	Truck, tools	.....	3	10	Truck, heater, tools
North Carolina:										
Chatham	Graded	35,000	400	400	Graded	Truck, tractor road machines drag	Graded	3	4	Drag, trucks, tractor, road machine
Columbus	Top soil	..	40	70	Top soil and sand-clay	Truck, drag, shovels	Top sail and clay	4	4	Truck, drag, road machine, scarifier
	Sand-clay	..	30							
Durham	Unimproved	50,000	950	..	.....	.....	.....	..	..	.....
Iredell	Sand-clay	120,000	500	500	Sand-clay	Tractor, truck, road machine, drag	Sand-clay	10	6	Wagons and mules, tractors, trucks, road machines
	Bit. concrete	5,000	29							
McDowell	Unimproved	20,000	1,100	..	.....	.....	Unimproved	..	Various	Various
Yadkin	Unimproved	1,000	60	65	Top soil	Truck	.....	..	..	.....
	Graded	4,000	150							
	Top soil	5,000	65							
	Sand-clay b	25,000	60							
North Dakota:										
Burleigh	Graded	9,900	115	148	Earth & Gravel	4 horses, 8 ft. blade, road maintainer, drag, slip scraper	.....	..	..	.....
	Gravel	..	27							
	Concrete	750	1.1							
Dunn	Graded	3,500	250	..	.....	.....	All	28	2 to 6	Plow, scraper, fresno, shovels; in some cases graders and trucks
McLean	Graded	13,782	693	693	Earth	Patrol graders, drags, 4 trucks	County pike	1	10	3 10-ton tractors, 3 12-ft. graders
Mountrail	..	..	..	95	Dirt	4 army trucks with 16 ft. iron drags; two 2-horse patrols with 6 ft. blades	Dirt	7	Valves	Truck, drag, 6 ft. blade, mower, Ford car
Pembina	Unimproved	11,000	240	240	.....	.....	.....	..	..	.....

Pembina	Unimproved	11,000	240	240	Earth	Patrol grader, drag	.....	..	..	.....
Pierce	Top soil	5,000	20	20	Gravel	.....	.....	..	..	.....
Slope	Graded	1,450	78	..	.....	.....	Graded	1	2	Engine and planer
Stutsman	Graded	8,500	212	226	Earth & Gravel	Drag, blade hauled by truck or team	Earth	2	3	Caterpillar and 12 ft. blade
	Gravel		14							
Walsh	Unimproved	6,500	64	64	Dirt	Patrol grader, dump wagon and team, mower, shovels, harrow	.....	..	..	.....
Wells	Graded	2,196	36	36	Dirt and gravel	Drag, grader, road leveler	.....	..	..	.....
Ohio:										
Auglaize	Gravel	..	225	..	.....	.....	All county roads	1	4	Grader, drag, trucks
	Bit. macadam	800	16							
	Concrete reinf.	85	14							
	" not "	150	15							
	Brick	120	9.5							
Clark	Gravel	58,000	254	254	Gravel	Grader, drags, small tools	Gravel	28	3 to 8	Graders, drags, small tools, tractors, steam road roller
Defiance	Gravel			..	.....	.....	.....	2	6 to 8	Trucks, graders, cold patch outfit
	Macadam									
	Bit. macadam	60,000	150							
	Concrete reinf.									
	" not "									
Fayette	Unimproved	80,000	207	..	.....	.....	207	10	3	Truck, 3 graders, 5 unloaders
Hardin	.....	..	..	..	.....	.....	.....	2	2	Roller, grader, 10-ton tractor and grader
Harrison	.....	..	..	..	.....	.....	County macadam	1	8	Two 3-ton trucks mixer, heater, etc.
Jackson	Gravel	..	120	..	.....	.....	County	2	2 to 20	Roller, grader, trucks, small tools.
	W. B. macadam	..								
Jefferson	W. B. macadam	64,554	158.65	20	Bit. macadam, W. B. macadam	Shovel, pick, mattock	W. B. macadam	4	8 to 10	Shovels, picks, 2 trucks, grader, tractor; one roller for all gangs
	Bit. macadam	47,766	69.75							
	Brick	1,000	2.0							
Madison	Bit. macadam	3,000	40.5	40	Gravel	One-man maintainer, drag, etc.	Gravel	10	1	Maintainer, drag, etc.
Marion	Unimproved		258	..	.....	.....	All kinds	2	4	Ford truck, tar kettle, small tools
	Gravel		106							
	Macadam		377							
	Bit. macadam	80,000	60							
	Bit. concrete		2							
	Brick		6							
	Sheet asphalt		2							
Preble	Gravel	14,461	773	..	.....	.....	Gravel	3	..	Quad, Ford trucks, grader, picks, shovels, wood drags, chain
Sandusky	W. B. macadam	85,000	85	..	.....	.....	Surface treated macadam	2	12	2 rollers, 2 graders, 2 sprinklers, 1 concrete mixer, 1 tar kettle, 3 trucks
Union	Gravel	25,000	347.8	15	Stone	Drag, 6½ ft. blade	Stone	4	3	Truck, drags, grader
	Macadam	20,000	293.3	..	.....	.....	.....	..	..	.....
Van Wert	.....	..	..	160	Stone & Gravel	Light grader (stone and gravel placed by County equipment)	Distributing stone and gravel	1	2	Truck
Warren	.....	..	..	240	Gravel	Truck, grader, maintainer, small tools	Gravel	5	3 to 5	Truck, grader, maintainer
Oklahoma:										
Comanche	Unimproved	6,000	150	150	Dirt	Grader, drag	State	8	1	Grader, drags, shovels
Grady	Graded	20,000	234	..	.....	.....	Graded	9	2	Tractor, grader
Okmulgee	Graded	150,000	800	70	Various	Team, asphalt kettle, small concrete mixer	Paved	1	3	.....
	Gravel	2,500	20							
	Concrete not reinf.	500	18							
	Topeka top	6,000	12							
	Shale	4,300	15							
Rogers	Unimproved	25,000	..	..	Dirt	.....	.....	..	..	.....
Oregon:										
Clatsop	Graded	1,000	10	15	Rock	Truck	Rock	3	2	Grader, small tools
	Gravel & macadam	2,000	15.5							
	Bit. concrete	1,550	16							
Deschutes	Graded	300	16	92	Macadam	3-ton truck, 8 ft. grader, small tools	.....	3	2	Truck, grader, small tools
	Gravel & crushed rock	20,000	92							
Douglas	Unimproved		333	955	All	Grader, drag, etc.	Market roads	66	2 or 4	Grader, drags, plows, fresnos, etc.
	Gravel	100,000	602.5							
	Plank		17							

a—Includes bridges. b—By State. C—Monolithic brick, $200 a mile; bituminous filled brick, $100 a mile. d—State roads only. e—800 miles for 60 days in the spring.

Highway Funds by States

State	Federal Aid spent by State in 1924	Furnished by State	Furnished by Counties, Towns, etc.	Federal Aid available for 1925	Will be furnished by State in 1925	Will be furnished by Counties, Towns, etc
Arizona	968,125	1,414,725	241,702	2,217,040	1,450,000	131,000
Arkansas	1,550,000	2,500,000	4,500,000	1,500,000	2,500,000	3,000,000
California	3,556,685	13,900,520k	262,448	5,464,591	15,220,000	274,000
Colorado	1,526,226	4,102,341	.....	1,350,000	3,200,000	.....
Connecticut	486,918	418,760	None	860,000	.....	.....
Delaware	365,000	1,794,032	1,499,184	365,000	2,000,000b	2,000,000
Florida	1,718,586	7,718,586	included in preceding am't.	887,337	5,794,814	.....
Georgia	1,224,676	300,658g	1,223,022g	2,000,000	1,200,000g	2,000,000g
Indiana	3,704,940	11,000,000	.....	6,000,000	12,000,000	....
Iowa	2,000,000	9,138,736	.....	2,078,000	9,000,000	None
Kansas	1,800,000	None	2,500,000	2,074,360	300,000	2,000,000
Kentucky	2,208,911	13,260,966	.....	2,000,000	5,000,000	.....
Louisiana	1,523,718	4,046,478	3,483,408	1,372,597	5,067,923	2,345,679
Maine	715,027	2,238,583	550,779a	1,032,706	2,000,000	535,464a
Maryland	635,945	2,050,000	600,000f	635,783	2,050,000	600,000f
Massachusetts	1,044,000	9,000,000	2,200,000	1,000,000	8,500,000	3,000,000
Michigan	4,287,242	14,950,000	5,502,982	3,500,000	.....	.....
Minnesota	3,530,274	5,438,330	3,930,517	3,005,998	8,775,000	508,496
Mississippi	2,250,000	2,325,000d	.....	2,294,000	2,400,000d	.....
Missouri	4,095,555	13,862,624c	2,460,433c	2,520,421	22,043,500c	922,200c
Montana	1,275,000	50,000	375,000	3,600,000	None	.....
Nebraska	1,987,955	1,236,070	770,322	4,500,000b	3,000,000b	.....
Nevada	2,146,590	276,000	.....	947,623	342,000	.....
New Hampshire	543,307	366,908	366,908e	422,541	211,271	211,271e
New Mexico	3,724,611	689,219	.....	2,000,000	600,000	.....
New York	3,195,494	20,000,000	.....	3,663,106	25,650,000	.....
North Carolina	1,477,424	25,889,201	1,621,009	1,697,246	25,000,000	4,000,000
North Dakota	1,225,368	280,000	900,000	2,500,000	600,000	600,000
Ohio	2,776,996	11,802,208	4,009,760	1,808,135	11,361,554	1,460,000
Oregon	2,837,366	14,269,971	22,000,000j	6,250,000	60,000,000	26,500,000
Pennsylvania	3,816,977	42,157,842i	33,500	650,000	2,560,000	None
Rhode Island	250,000	2,250,000	3,944,985f	1,664,620	5,000,000	.....
South Carolina	1,189,633	1,353,422h	2,398,060	4,668,341	5,700,000	4,000,000
South Dakota	2,062,000	3,518,000	5,250,000	1,215,000	2,600,000	5,500,000
Tennessee	3,517,365	4,325,474	.....	5,035,322	6,000,000	.....
Texas	6,468,540	4,374,802	.....	1,325,000	1,100,000	.....
Utah	1,324,064	1,482,576	1,000,000	365,625	2,300,000	1,100,000
Vermont	600,000	2,000,000	1,400,000	1,448,000	14,479,049	1,400,000
Virginia	1,448,563	17,193,283	137,585c	2,000,000	7,000,000	.....
Washington	1,212,403	6,479,856	5,000,000	798,245	9,245,212	.....
West Virginia	602,688	11,424,359	12,319,440	1,877,600	8,500,000	10,497,742
Wisconsin	1,141,881	6,461,792	14,000,000	2,789,588	10,500,000	7,500,000
Wyoming	1,751,287	1,461,330	1,000,000	1,100,000	1,200,000	1,000,000

a—Expended under direction of State Highway Commission. b—For 1925 and 1926. c—State highway system exclusively. d—Amount furnished by state is transferred from counties. e—By towns only. f—By counties only. g—Construction only. h—For betterment $58,076; for maintenance $1,295,346; obtained from motor vehicle licenses and gasoline taxes. i—$18,814,835 for new construction, $23,343,008 for general maintenance, including replacement, resurfacing, surface treatment, oiling earth roads, etc. j—$14,000,000 by townships on township highways, $8,000,000 by counties and townships for work done by Dept. of Highways. k—Construction, maintenance and reconstruction.

Clearing Drainage Ditch with Dynamite

By H. C. McClure*

Although ditching with dynamite has become quite common in recent years, perhaps the experience of the Engineering Department of the city of Flint, Michigan, may prove interesting to others contemplating such work.

Within the city limits of Flint are several small lakes and near one of them is a summer amusement park. Each year, about the time the park is scheduled to open, high water, due to spring rains, has interfered with the plans; for an old county drainage ditch, which serves as an outlet for the lake, has failed to meet the requirements. To give adequate relief we found it necessary to clear this ditch for a distance of approximately 7,500 feet.

*City Engineer of Flint, Michigan

Along this stretch were found heavy clay and gumbo soil, a stretch of swamp land and a portion of timbered area. Any one method of opening and deepening the ditch for its entire length was out of the question, but the job was not big enough to warrant bringing in the several types of equipment best adapted for the different portions. Shovels or draglines could not operate through the swamp because of no bottom; nor could they operate through the woods for lack of clearance. Slips were not advisable through the swamp and could not be used on the farm land section because of the heavy clay and gumbo. Land dredges could not well be brought into the swamp section. It was finally decided to use dynamite at a time when the drainage ditch carried enough water to warrant blasting by the propagation method.

Short test sections were blasted at first to determine the size of cartridges and the space and depth at which they would give best results. Finally, it was decided to use half-pound sticks of fifty per cent straight dynamite in holes spaced fourteen or fifteen inches apart and with the charges placed at a grade of four to six

Road Improvement in 1924 Under State Supervision

State	Grading	Earth Surfacing	Gravel	Plain Macadam	Bituminous Macadam	Bituminous Concrete	Cement Concrete Reinforced	Cement Concrete Not Reinforced	Brick	Other Kinds Kind	Other Kinds Amount
Arizona	..	93.86	103.76	..	..	8.05	..	15.92	..	.....	..
Arkansas	800d	..	415	15	15	51	..	50	..	.....	..
California	282.8	..	145.3	..	52.5	10.1	..	29.2	..	Reconstructing grades	39.0
										Reconstructing pavements	87.5
Colorado	65	..	125	..	..	4.0	..	57.3	..	.....	..
Connecticut	..	..	0.66	37.91	35.56	12.02	45.49	..	0.07	.....	..
Delaware	..	..	..	..	..	..	..	71	..	.....	..
Florida	28.5	98.8	..	..	31.6	..	..	20.6	0.8	Sheet asphalt	25.2
										Surface treated rock base	153.5
										Marl surface	26.0
Georgia	..	202.1	59.6	13.8	9.4	..	..	3.3	0.2	.....	..
Indiana	108.11	..	19.22	..	..	..	237.59	..	..	Sheet asphalt	2.0
Iowa	459	..	355	..	..	..	95	..	..	.....	..
Kansas	188	..	89	..	11	..	..	138	44	.....	..
Kentucky	340	..	179	162	21	..	54	..	..	Rock asphalt	37
Louisiana	..	..	727	..	..	..	..	..	..	.....	..
Maine	..	..	330.9	0.3	26.9	..	1.8	..	..	granite block	0.8
										Sheet asphalt	3.6
Maryland	0.7	..	34.9	..	25.5	..	..	87.1	0.7	3 ft. concrete shoulders	24.1
Massachusetts	..	..	56.7	1.3	75.2	35.3	28.1	..	..	.....	1.3
Michigan	63	..	340	26	12	35	40	396	..	.....	..
Minnesota	568.2	..	199.7	..	..	4.4	76.1	..	1.5	.....	..
Mississippi	59	..	162	..	..	10	..	14	2.8	.....	..
Missouri	637	..	383	..	23	..	..	136	..	9 ft. concrete & 7 ft. gravel	89
Montana	..	..	190	..	..	..	..	..	..	.....	..
Nebraska	371.7	74.2	470.0	..	..	0.57	..	12.6	2.8	.....	..
Nevada	115.5	..	187.5	..	5.0	..	6.5	..	..	Oil-sand	10.0
New Hampshire	..	..	111e	1.0e	19.0e	..	3.6f	..	..	Modified asphalt	4.7
New Mexico	4.0	..	345.6a	..	..	..	18.8b	..	..	.....	..
New York	..	..	..	..	103.1	..	244.0	..	0.5	Wood block	0.2
										Asphalt block	0.7
North Carolina	430	1,500	304	211	..	659	697g	..	10	.....	2
North Dakota	303.4	..	125.9	..	..	..	0.5	..	..	.....	..
Ohio	63h	22	300	40	157	..	164	24	111	.....	92
Oregon	171.1	..	201.7a	..	..	..	..	15.9	..	Stone or gravel resurfacing	127.5
Pennsylvania	..	..	35.18i	..	72.90	37.61	582.74	1.38	2.17	Bit. surface treated macadam and oil bound macadam	475.49
Rhode Island	..	..	4.5	1.0	9.0	5.5	19.0	..	..	.....	..
South Carolina	488.4	431.6	16.0	..	..	15.6	..	9.2	..	Sheet asphalt	16.0
South Dakota	950	..	420	..	..	..	0.4	..	..		
Tennessee	195.9	..	127.2c	10.9	101.9	26.4	..	53.7	..	Sheet asphalt	18.2
										Surface treatment	19.2
										Rock asphalt	22.5
										Burnt slate	10.0
Texas	166.8	..	417.3	..	183.2	25.0	54.3g	5.0	..	Shell, caliche or sand-clay	10.4
Utah	21.1	..	154.8	..	..	2.8	..	18.7	..	.....	..
Vermont	125	..	1.5	..	10	..	13	2	..	.....	..
Washington	69d	..	281	..	..	..	29	..	..	.....	..
West Virginia	253.7	..	50.7	30.57	50.14	5.30	..	73.75	0.57	Shale	22.61
										Rock asphalt	17.86
										Sheet asphalt	0.71
Wisconsin	245	..	1,000	..	15	..	..	274	..	.....	..
Wyoming	286	..	205	..	..	22	..	..	..		

a—Includes crushed stone. b—Partly reinforced. c—Or chert. d—Includes earth surfacing. e—Includes reconstruction. f—Reconstruction only. g—Includes not reinforced also. h—Including bridges. i—Includes stoned roads.

inches above the proposed ditch bottom. The charges were set off with a blasting machine. Short sections were blasted first, then longer ones, until 150 feet was found to be the proper length for each shot.

On encountering the clay and gumbo it became necessary to place an extra booster stick about every ten to fifteen spaces. While it was perhaps unnecessary in this section, connections were also made at points approximately twenty-five feet each side of the center in addition to the center connection.

In the swamp land, with its dense growth of marsh grass and with water in places two feet deep, the heaviest gumbo soil was encountered. The ditch through the woods was a mass of broken limbs and roots, so that after blasting, the men had to gather and burn large quantities of brush and rubbish. On the other sections it was necessary only to dress down the banks where pieces of material had been loosened and only partially dislodged. In the clay section large chunks up to a cubic foot in size were thrown clear of the ditch. Thus, despite the variable soil conditions, the ditch was satisfactorily opened and deepened.

For the most part the work was done in open territory and mats or other protection were unnecessary. The only "casualty" was one window pane in a farm house, which the concussion of a blast shattered.

The City Engineering Department undertakes practically all public improvement work in Flint. This ditch blasting job, including the work of cleaning up the banks, was accomplished by six employes of the department who finished the task in approximately three weeks' time. Eleven thousand one-half pound sticks of fifty per cent straight dynamite were used. The total cost of cleaning 7,500 linear feet of ditch was approximately $3,100, which included department overhead charges in addition to construction items.

Recent Legal Decisions

HIGHWAY CONTRACTOR'S LIABILITY FOR INJURIES TO EMPLOYEES

The Kentucky Court of Appeals holds, J. Harvey Vandever & Son v. Hardin's Admr. (Ky.) 238 S. W. 306, that the contractor of the county or the state, though independent, is not liable for injury to a third person traveling along a defective highway or otherwise injured by reason of work performed by the contractor for the county or state; but a contractor who undertakes on his own account for a named consideration to do certain work for the county or state upon a public highway or to furnish his own help and to do all the work, employing his own methods in the performance of a contract to construct or reconstruct a highway is liable for injuries to his employees resulting directly from his negligence.

GROUND FILLED WITH BOULDERS HELD PROPERLY CLASSIFIED AS LOOSE ROCK

A road construction contract provided for the division of the material moved into three classes, denominated earth, loose rock, and solid rock—specifying that all sand, clay, loam, gravel and other material not included in the classification for loose and solid rock should fall in the class called earth. It defined the class loose rock to include all slate, shale, or other rock which cannot be plowed with a 10-inch road plow and four-horse team, but which can be quarried or loosened with a pick, and the class solid rock to include all rock in masses which cannot be loosened with a pick. The Minnesota Supreme Court held, by a divided court, Foley Bros. v. St. Louis County, 197 N. W. 763, that the trial court was amply justified in finding that, where the ground was so infested with boulders that it was impracticable to plow it, the whole mass so filled with boulders should be classified as loose rock.

COUNTY COMMISSIONERS CANNOT CONTRACT WITH LANDOWNER BEYOND AUTHORITY

The Kansas Supreme Court holds, Haucke v. Board of Comrs. of Morris County, 224 Pac. 64, that a county board of commissioners, in establishing and opening a public road, has no authority to enter into a contract with a landowner through whose land the road is laid to build and maintain a chute or runway across and under the highway through which live stock can pass from one tract to the other. In the absence of express authority the damages sustained by a landowner cannot be adjusted or allowed in any manner other than is prescribed by statute, and the landowner cannot insist on the fulfillment of promises or agreements which the board was without authority to make.

METHOD FOR ABATEMENT OF FIRE HAZARD

The Washington Supreme Court, City of Seattle v. Seibert, 225 Pac. 67, holds a fire hazard defined and forbidden by a general ordinance, may be abated in any lawful manner other than that provided in the general ordinance, and a special ordinance directing the corporation counsel to take proceedings for its abatement is not invalid because the method is different from that provided by the general ordinance.

MUNICIPALITY NOT LIABLE TO SURETY FOR MONEY PAID CONTRACTOR'S ASSIGNEE BEFORE DEFAULT

The Kansas Supreme Court holds, United States Fidelity & Guaranty Co. v. City of Pittsburgh, 225 Pac. 83, that a city government may lawfully bind the city to pay to an assignee of a creditor of the city a sum of money actually due the creditor at the time the city government approved the assignment and ordered payment thereof.

A bonding company guaranteed performance of a sewer contract and on the contractor's default after he had completed most of the work and had been proportionately paid therefor, the bonding company finished the job and sued the city for a sum paid to a bank under an order and assignment by the contractor and accepted by the city before the contractor's default, but not actually paid until such default. The bonding company claimed that the city should have withheld the money from the assignee and handed it over to the company. It was held that, the money being due to the contractor when it was assigned, and thereafter due to his assignee, it was neither a deferred payment nor a retained percentage to which the bonding company could lay claim under its contract of indemnity with the contractor, nor as the contractor's successor in interest.

CONSTITUTIONAL LIMITATION HELD NOT TO PREVENT INDEBTEDNESS FOR FILTRATION PLANT

The Washington Supreme Court holds, by a divided court, McCarthy v. City of Kelso, 223 Pac. 151, that the constitutional limitation on municipal indebtedness does not apply to the construction of a water filtration plant for the preservation of the health and lives of the citizens where the state board of health had directed the discontinuance of the water from its existing waterworks and there is no other method whereby wholesome water can be supplied.

SUFFICIENT DESCRIPTION OF PROPOSED IMPROVEMENT IN RESOLUTION

The California District Court of Appeals, First District, holds, Walsh v. Swanson, 222 Pac. 190, that the general description of a proposed street improvement in the resolution of intention is to be read with the plans and specifications adopted for the improvement and referred to in the resolution, and a description as "the construction of an artificial stone sidewalk of the full official

width, where not already constructed, at least six feet wide," was held sufficient.

BINDING EFFECT OF ACCEPTANCE OF PAVING IMPROVEMENT PLANS—POWER TO ACCEPT BIDS HELD NOT DELEGATED

In an action against an abutting owner to recover his proportionate share of street paving, the Louisiana Supreme Court holds, City of Shreveport v. Levy, 98 So. 431, that where all the interested parties, the city, the property holders, and the contractors, had accepted the plans and specifications, neither could be held to complain, on completion of the work, that the city council did not prepare the plans and specifications, as required by statute. The fact that the council referred the bid to the commissioner of streets and parks and to the city engineer for examination and report was not a delegation to others of the council's power to accept the bid, no power to accept or reject the bid, or to alter or amend it in any respect, being delegated to these officers.

ROAD-GRADING CONTRACT; PAYMENT FOR REMOVAL OF BREAKAGE AND SLIDES; ENGINEER'S MONTHLY ESTIMATES HELD NOT CONCLUSIVE ON CONTRACTOR

The West Virginia Supreme Court of Appeals holds, T. Towles & Co. v. County Court of Summers County, 121 S. E. 93, that under a road grading contract at a specified price per yard, providing that work done beyond the lines and grades shown on the plan, or as given, except as therein provided, or any extra work done without written authority, will be considered as unauthorized and at the contractor's expense, and will not be measured or paid for by the county, but that the contractor shall remove all breakage and slides, and that all excavation will be measured in its original position by the cross-section method, to ascertain the amount of material removed, which cross-section will include all breakage or slides removed, not attributable to carelessness on the part of the contractor, work done beyond the lines shown on the plan, or rendered necessary by reason of deviation from the lines, without authority of the county court or its duly authorized agent, is not to be measured, and the contractor cannot recover therefor.

The contractor was held entitled to all breakage and slides removed by him, due to the use of explosives in shooting the materials, unless they were caused by his carelessness, or unless he fraudulently used excessive numbers or sizes of charges and thereby increased the yardage.

The county engineer's monthly estimates of work done and materials furnished on which 90 per cent of the whole was to be paid were held to be mere estimates or approximations thereof, and, in the absence of express and unequivocal terms in the contract making them so, they were not final and conclusive on the contractor as to quantities. Their main purpose, under such a contract, is to furnish a basis upon which monthly payments are to be made to the contractor; and in an action by the contractor for the balance claimed by him to be due for the excavation, the defendant claiming that he had been paid for all excavation done, after final estimate by the engineer, but which payment was accepted under protest, it was held error to instruct the jury that the monthly estimates could not be impeached, except for fraud, mistake or caprice amounting to fraud on the contractor.

BUILDING LINES WHERE STREAM RUNS THROUGH CITY

The West Virginia Supreme Court of Appeals holds, City of Welch v. Mitchell, 121 S. E. 165, that a city, authorized by its charter to make proper regulations for guarding against danger or damage from fire, water, or other element, and to regulate the construction of buildings, may, as a proper exercise of its police power, adopt reasonable restrictions for buildings upon lands along a stream flowing through the city, so as to avoid danger from floods. To this end it may adopt an ordinance fixing building lines on each side of the stream, beyond which it may prevent the owners of lands bordering thereon from constructing their buildings, even though their title extends to the middle of the stream; and if the restrictions be reasonable, a riparian owner is not entitled to compensation for that portion of the land he is thus forbidden to use. But the city should not change uniformly fixed building lines on each side of the stream without notice and hearing. And the city cannot after adopting an ordinance fixing building lines 30 feet from each side of the middle of the stream, by subsequent ordinance permit owners on one side to encroach beyond the building line and prevent owners on the other side from building up to the line as originally established.

TOO LATE TO OBJECT TO PAVING IMPROVEMENT AFTER COMPLETION AND ACCEPTANCE

The Georgia Supreme Court holds, City of Bainbridge v. Jester, 121 S. E. 798, that it was too late for abutting owners to object to the validity of paving assessments after the completion of the work and its acceptance by the city authorities, especially after the city council had afforded ample opportunity to the complainants to object to the execution of the contract and the consequent assessments.

BUILDING ORDINANCE FAILING TO SPECIFY RULES AND REGULATIONS HELD VOID

The West Virginia Supreme Court of Appeals holds, State v. Town of Ripley, 121 S. E. 725, that an ordinance which fails to specify rules and regulations for the erection of buildings and their location within the corporate limits, but grants to the common council the right to grant or withhold its permission to erect buildings thereon, is void. There being no valid ordinance, mandamus would not lie to compel the common council to grant a building permit.

PAVING SEVERAL STREETS AS A SINGLE IMPROVEMENT

The North Carolina Supreme Court holds, Leak v. Town of Wadesboro, 186 N. C. 683, 121 S. E. 12, that when an improvement of streets by a municipal corporation constitutes a single scheme, the ordinance may provide for the pave-

ment of several streets, a single street, or a portion of a street; and when streets are practically similar and are to be paved in the same manner and with the same material and are grouped as a unit, in the absence of provision to the contrary, they may generally be treated as a single improvement. Physical connection between the different portions is not absolutely essential.

CITY NOT PRINCIPAL CONTRACTOR UNDER WORKMEN'S COMPENSATION ACT

The Virginia Supreme Court of Appeals holds, Bamber v. City of Norfolk, 121 S. E. 564, that a city is not a principal contractor so as to be liable as such under the State Workmen's Compensation Act for the death of an employe of an independent contractor erecting a standpipe, part of the city's water system.

UNAUTHORIZED SIGNATURE TO IMPROVEMENT PETITION CANNOT BE RATIFIED AFTER PASSAGE OF IMPROVEMENT ORDINANCE

The Arkansas Supreme Court holds, Lipscomb v. Blauz, 258 S. W. 624, that an attempted ratification of an unauthorized signature to a street improvement petition after passage of the improvement ordinance was unavailing, and, the council having no authority to pass the ordinance creating the district, the commissioners were enjoined from attempting to proceed under it.

RESOLUTION RESCINDING FORMER RESOLUTION TO PURCHASE LAND

A city council passed a resolution appropriating a sum for the purchase of land for a city hall, and subsequently, before the expiration of the time during which the mayor had the right of veto, it adopted a resolution indefinitely postponing the resolution of purchase. The Wisconsin Supreme Court holds, Winninger v. City of Waupun, 197 N. W. 249, that in passing the second resolution indefinitely postponing the resolution of purchase, the council intended to and did effectually dispose of such resolution, and such action resulted in rescinding the offer of purchaser therein.

CONSTRUCTIVE NOTICE OF CONDITION OF MANHOLE FOR JURY

In an action for damages for injury caused by stepping on the lid of a manhole over a catchbasin in the sidewalk, which tilted and slipped, letting plaintiff's leg into the cavity, it was held, Bayne v. Kansas City (Mo. App.), 263 S. W. 450, that whether the manhole cover was in a dangerous condition, and whether such condition existed for such a length of time as to give the city constructive notice, were questions for the jury.

CONSTRUCTION OF PROVISION MAKING ENGINEER'S DECISION FINAL

The contract of a road district engineer provided that he should do all the engineering work connected with the improvement and pay all the expenses incident thereto for a percentage of the construction cost.

The specifications prepared by the engineer were made a part of the contract, and it was provided, among other things, that the engineer's decision as to the meaning of all specifications should be final. The Arkansas Supreme Court holds, Connelly v. Parkes, 255 S. W. 22, that under this provision the engineer's decision as to the number of employees necessary to assst him in laying out and measuring the work and inspecting the materials and the compensation therefor was final. This provision of the contract was held to have reference wholly to any controversy that might arise between the district and the contractor as to the meaning of the specifications in the contract. It had no reference to the interpretation of the contract provisions, or of the specifications, in determining any issue that might arise between the contractor and the engineer as to the individual and personal duties and liabilities of one to the other growing out of their respective contracts with the district.

The running of levels, setting slope stakes, and inspecing materials was held to be "engineering work" within the contract, and not work for the contractor, for which he must pay, notwithstanding the contractor's agreement provided that he should "furnish such reasonable amount of help as the engineer may desire in laying out and measuring the work or inspecting material."

MUNICIPALITY'S LIABILITY FOR SETTING FIRE TO BUILDING BY BURNING RUBBISH PILED IN STREET

The Missouri Court of Appeals holds, Adams v. City of Frankford, 251 S. W. 125, that municipality in clearing a street of weeds, brush and small trees was acting in a private or ministerial capacity and was liable for the negligence of its servant in causing brushwood to be piled close to a barn and burned, setting the barn on fire.

EFFECT OF PROVISION FOR ARBITRATION IN PUBLIC CONTRACTS

Contracts which provide for arbitration of questions in dispute before bringing action are enforceable. A city is entitled to its right not to be sued upon the failure or refusal of a contractor to arbitrate differences and at the same time engages in delay in the performance and completion of important public works, as is the contractor entitled to the benefit of a plan insuring a prompt and inexpensive adjustment of compensation he claims to be due him, where they enter into a contract to that effect. The Washington Supreme Court holds, Jackson v. City of Walla Walla, 226 Pac. 487, that the rule applies especially where the contract provides that arbitration shall be a condition precedent to any action at law, but where the contractor has abandoned the work it was not contemplated in the contract that the city could be called upon to arbitrate with him after he had abandoned the contract, or lose its right to contend that it could not be sued in an action at law if an appeal to a board of arbitration was not taken before the contractor had terminated the contract.

DRAINAGE INCLUDED IN PAVING EXPENSES

The Minnesota Supreme Court holds, In re Meyer, 197 N. W. 970, that drainage is an indispensable part of a paving project, the cost of which may be properly included in the general expense of the improvement. The inclusion of the engineer's expenses is a question particularly for the council and the trial court.